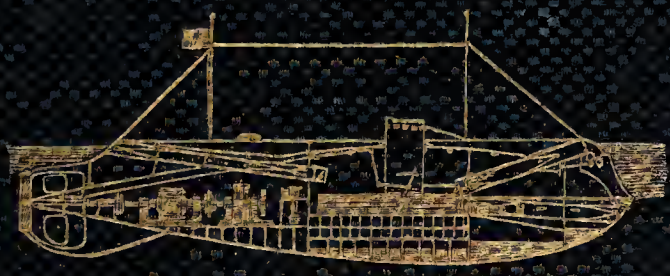

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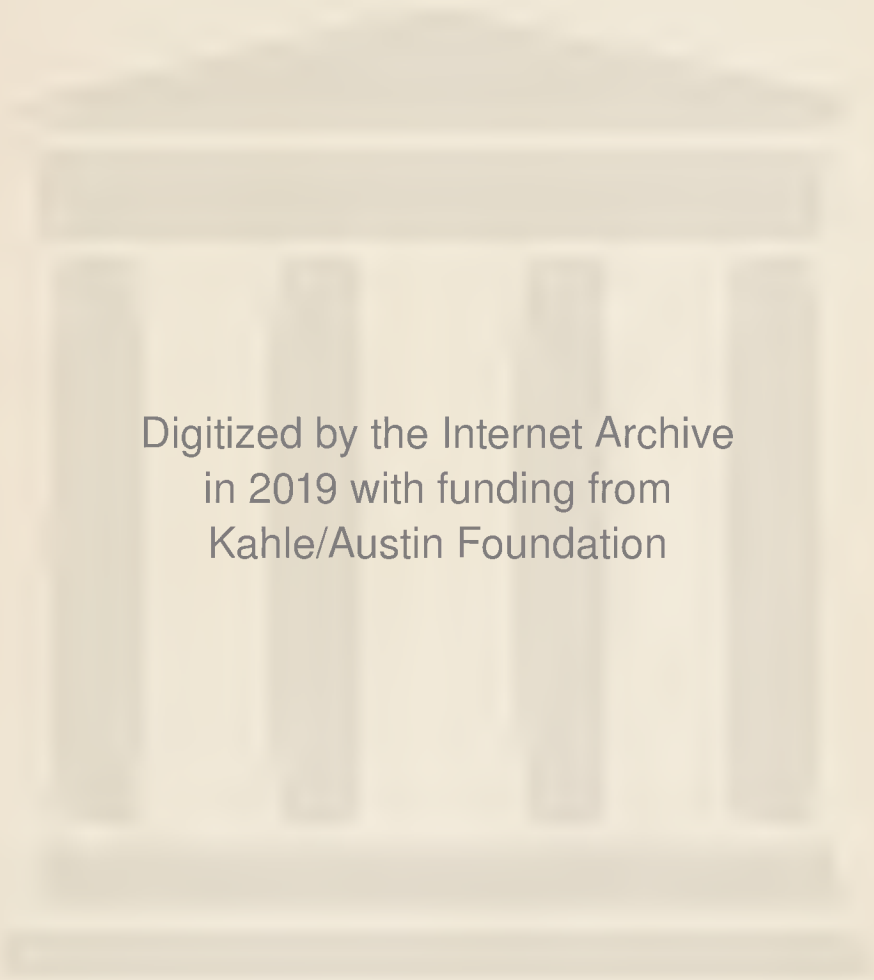
SUBMARINE NAVIGATION



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CLXXX. J. P. HOLLAND, ESQ.

SUBMARINE NAVIGATION

PAST AND PRESENT

BY

ALAN H. BURGOYNE, F.R.G.S.

ILLUSTRATED

VOLUME II

LONDON: GRANT RICHARDS

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1903

VIT 365

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SUBMARINE NAVIGATION

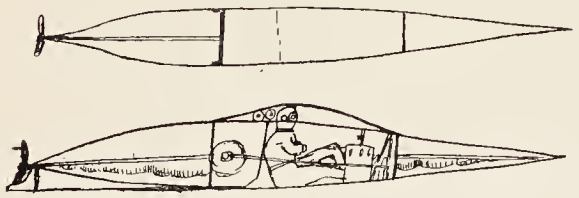
PART V

THE HOLLAND SUBMARINE BOATS.

ALTHOUGH Mr. John P. Holland, of Paterson, New Jersey, U.S.A., made a number of experiments in the sixties, his first real boat was not built until 1875.

HOLLAND NO. I.

The 'Holland No. 1' may be described as an under-water canoe, for there was only room for one occupant, who propelled



CLXXXI.-CLXXXII. PLANS OF 'HOLLAND NO. 1'

the vessel by means of pedal-acting mechanism. The 'Holland No. 1' had the following dimensions:

Length	.....	16 feet
Beam	.....	20 inches
Depth	.....	2 feet

As may be seen by the illustration the vessel was divided into three parts; the two end ones were used as air reservoirs

and submersion tanks, that in the centre contained the solitary occupant whose head was encased in a diver's helmet. The vessel was driven by a small propeller projecting from the stern point and beneath this was the rudder. This submarine boat was a very rudimentary affair when compared to the latest designs by the same inventor and the advance made in 25 years is remarkable.

Holland No. 2.

The second boat was constructed in 1877 at the Albany City Iron Works of New York. Its dimensions were:

Length	10 feet
Beam	3.5 feet
Depth	3 feet

It had a double shell and submersion was obtained by admitting water ballast between the two hulls. The propeller was rotated by a 4 H.P. petroleum engine, and steering was effected by two rudders, one vertical and the other horizontal and by experiments carried out with this vessel, Mr. Holland discovered that the latter rudder acted with greater efficiency when placed in the stern than when on the sides. After a series of exhaustive trials on the Passaic River, the inventor removed all the machinery and interior fittings and sank his boat under the Falls Bridge at Paterson, where it probably remains to this day.

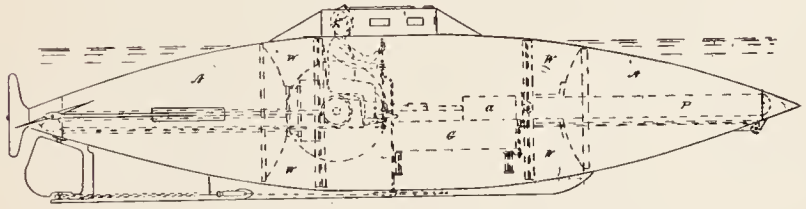
Holland No. 3.

Mr. Holland commenced building his third submarine in 1879, at the yards of the Delamater Iron Company of New York City, from which place the 'Holland 3' was successfully launched in 1881. It had the following dimensions:

Length	31 feet
Beam	6 feet
Depth	6 feet
Displacement	19 tons

The propulsive power was an oil engine of 15 H.P. of the

Brayton type. The armament consisted of a submarine cannon 11 feet long and 9 inches in diameter from which a projectile was expelled by means of compressed air, utilized at a pressure of 200 lbs. per square inch. With this apparatus Mr. Holland was able to drive a projectile in a perfectly straight line for a distance of 130 feet; he later endeavoured to exceed these results and increased the air pressure to 495 lbs., and strange as it may seem the range did not always increase with the augmentation of propulsive power. After many experiments a pressure of 250 lbs. was found to be the most suitable, and at this amount he stopped. The projectile, of which details are unobtainable, was constructed by the builders of the boat. This pneumatic cannon, the first of the type to come into existence, was founded of steel tube.



CLXXXIII. PLAN OF 'HOLLAND NO. 3'

Accompanied by an engineer, Mr. Holland made several cruises and proved that it was quite possible to leave and re-enter the boat by means of a manhole while it was under water.

'After the completion of this boat,' says Admiral Hichborn, 'Holland led the world far and away in the solution of submarine problems and for a couple of years demonstrated that he could perfectly control his craft in the vertical plane. Eventually through financial complications she was taken to New Haven where she now is.' In 1896 her air compressor was removed to work a forge, and she is now nothing but an empty hull.

HOLLAND NO. 4.

'Holland No. 4' was constructed in the yard of Messrs.

Gammon and Cooper, of Jersey City. It was little more than a model being of the following size:

Length	16 feet 4 inches
Beam	2 feet 4 inches
Depth	2 feet 4 inches
Displacement	1 ton

The motor was an explosive engine which was to serve for propulsion both above and below the surface. The life of this model was unfortunately short for on one occasion she was submerged with her cupola open with the result that the water entered and she sank.

Holland No. 5.

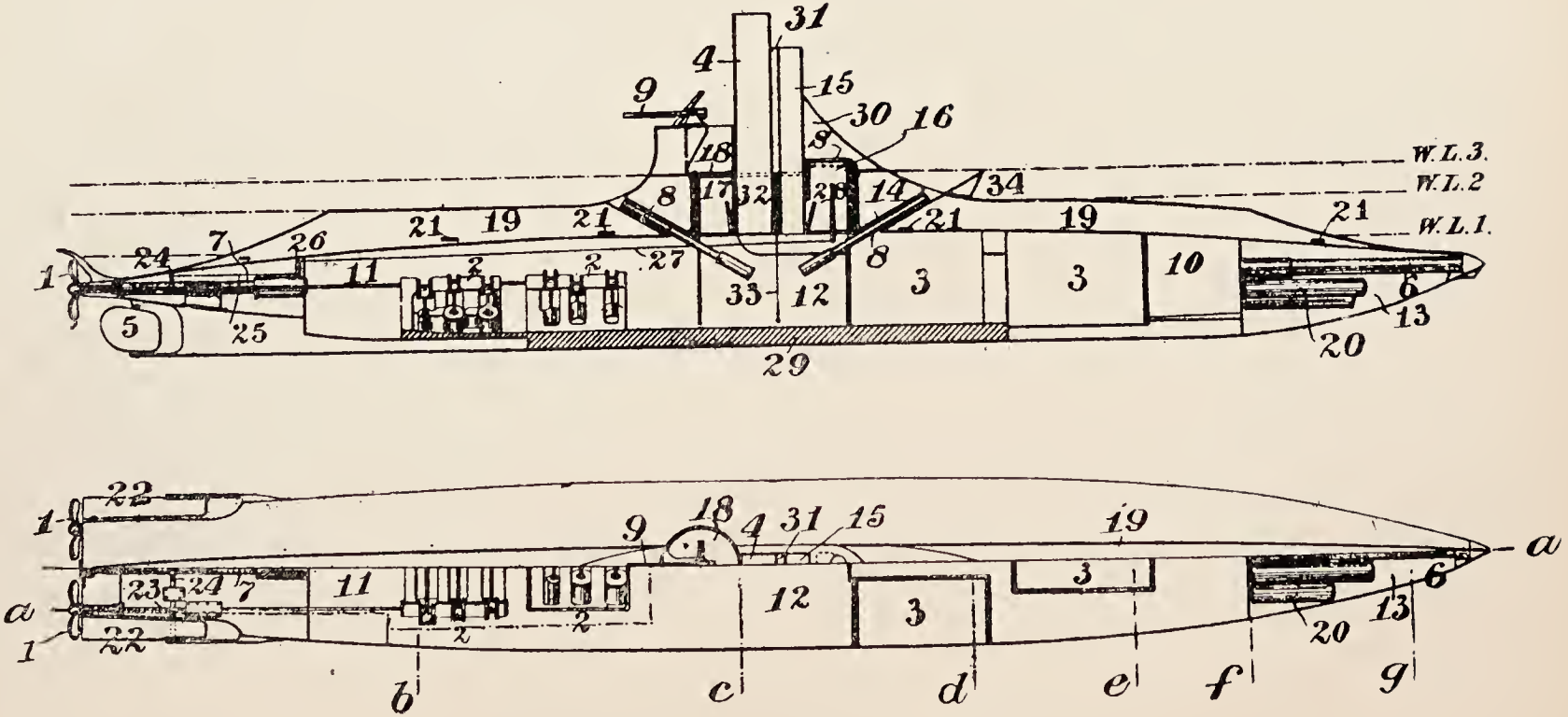
This vessel, commonly called the 'Zalinsky Boat,' owing to its dynamite gun, was built at Fort Lafayette. It was a great advance of its predecessors as regards size:

Length	39 feet
Beam	7 feet
Depth	7 feet

Owing to some fault in her construction, the 'Holland No. 5' lacked stability and was lost on the rocks before any trials could take place. Afterwards refloated a number of experiments were carried out with her in the docks. The great feature of this vessel was the armament which in time of war would have consisted of two Zalinsky pneumatic dynamite guns.

Holland No. 6.

This vessel, for which a patent was granted on May 21st, 1892, never went further than the design stage. From it sprang the plans of the 'Plunger' a description of which follows. I am able to reproduce a full size reproduction of the original designs and in it the chief features can be easily seen. In form it resembles more a surface vessel, and indeed,



CLXXXIV.-CLXXXV. PLANS OF 'PLUNGER I'

a great amount of its service was to have taken place on the surface. The means of propulsion comprised twin screws driven by two independent sets of steam engines, which were to be supplied by steam from two box boilers. The armament comprises a submerged gun placed in the bows, another of the same type in the stern arranged between the two screws; two inclined over-water guns directed fore and aft respectively, and a light quick-firing gun with a shield, mounted on a platform near the smoke-stack and always above the water level. As will be seen this is not a true submarine boat, it not being capable of complete submergence. Even at the greatest depth, when all except the funnel and air-shaft are about 18 inches under water, a large reserve of buoyancy is retained to allow a speedy return to the surface. The following explanations of some of the figures will aid in study of the plans:

1—Twin screws; 2—The engines; 3—Boilers; 4—Smoke-stack; 5—Rudder for ordinary steering; 6—Submerged bow gun; 7—Submerged stern gun; 8—over-water guns; 9—Quick-firing gun; 10—Forward gun room; 11—After gun room; 12—Central gun room and cabin; 13—Water ballast chamber; 14—Armoured caisson; 15—Air-shaft; 16—Conning-tower; 17—Protected companion way; 18—Platform on which the quick-firing gun is mounted; 19—Narrow hollow superstructure tapered laterally toward the bow and stern to form a cut-water when the boat is submerged; 20—Compressed air reservoirs in ballast chamber; 21—Apertures through which the water enters to fill superstructure; 22—Vertical rudders; 23—Rudder shaft; 24—Rudder crank; 25, 26, 27, 28—Rudder mechanism; 29—Ballast to counteract the weight of armoured caisson; 30—Triangular brace to assist the air shaft in parting the water; 31, 32, 33—Mechanism and sliding shield for closing up shot holes in funnel or air shaft; 34—A wave-cutter designed to cut or break the waves and prevent them from dashing into the sight-holes of the door.

No. 1 water-line indicates the normal water-line when the boat is not in action. No 2 denotes the water-line when the boat is submerged and prepared for action and No. 3 shows the water-line when the boat is rapidly advancing to the attack,

this water-line being obtainable only when the boat is in motion by the action of the water on the horizontal rudders in the stern.

Holland No. 7.

Whilst Mr. Whitney was Secretary for the Navy he was anxious to provide some kind of protection against gun-fire for torpedo boats and at the suggestion of his colleagues he invited proposals for submarine boats. A great number of designs were sent in and two propositions to build were made by the famous firm of Cramp, Philadelphia, the designs being those of Holland and Nordenfelt. As this chapter is a history of the former's vessels it is unnecessary to enter into a comparison between Holland's design and that of Mr. Nordenfelt; suffice it to say that while Nordenfelt obtained submersion by means of vertical screws and laid it down as a dogma that the keel of a submarine vessel must always be kept parallel to the surface of the water, Holland steered his boat up and down an incline by the action of horizontal rudders placed in the stern.

The 'Holland' design was accepted because 'it embodied the ideas of a fixed centre of gravity, of an exact compensation for expended weights, of a low longitudinal metacentric height, and of quick diving and rising, by the effort of the propeller pushing the vessel against the resistance of her mid-ship section only, down or up inclines, the angles of which were to be determined by horizontal rudder action.'

Difficulties in regard to the guarantee of performance prevented the closing of the contract that year—1888—and the next year after all the preliminaries had been arranged, a change in administration caused the matter to be put aside. After the lapse of some years interest in submarine boats was again aroused and on March 3rd, 1893, Congress authorised the building of a single experimental vessel and after the third completion of designs and other delays a contract for a 'Holland' boat was signed two years later with the Holland Torpedo Boat Company (formed in 1895). The new vessel

was to be called the 'Plunger.' The 'Plunger' had the following dimensions:

Length	85 feet
Beam	11½ feet
Depth	11½ feet
Displacement	140 tons
I.H.P. 1625	= 15 knots.
I.H.P. (electric) 200	= 8 knots

The radius of action at full speed was to be 180 miles on the surface, whilst at an economical speed 1,000 miles could be accomplished. The endurance when submerged was to be 10 hours at 6 knots.

The motive power was to have consisted of two independent sets of triple expansion engines having a combined power of 1,625 I.H.P. with which a speed of 15 knots on the surface and 14 when awash, was expected. Steam was to be supplied by five tubular boilers of the Mosher type, placed in three groups, two pairs in the centre of the vessel and one forward for the regulation of balance. For submerged navigation two electric motors having a power of 100 I.H.P. each were to be fitted and these could on occasion be used as dynamos for recharging the accumulators, motive power being obtained from the steam engine. The boilers were heated by combustion of oil.

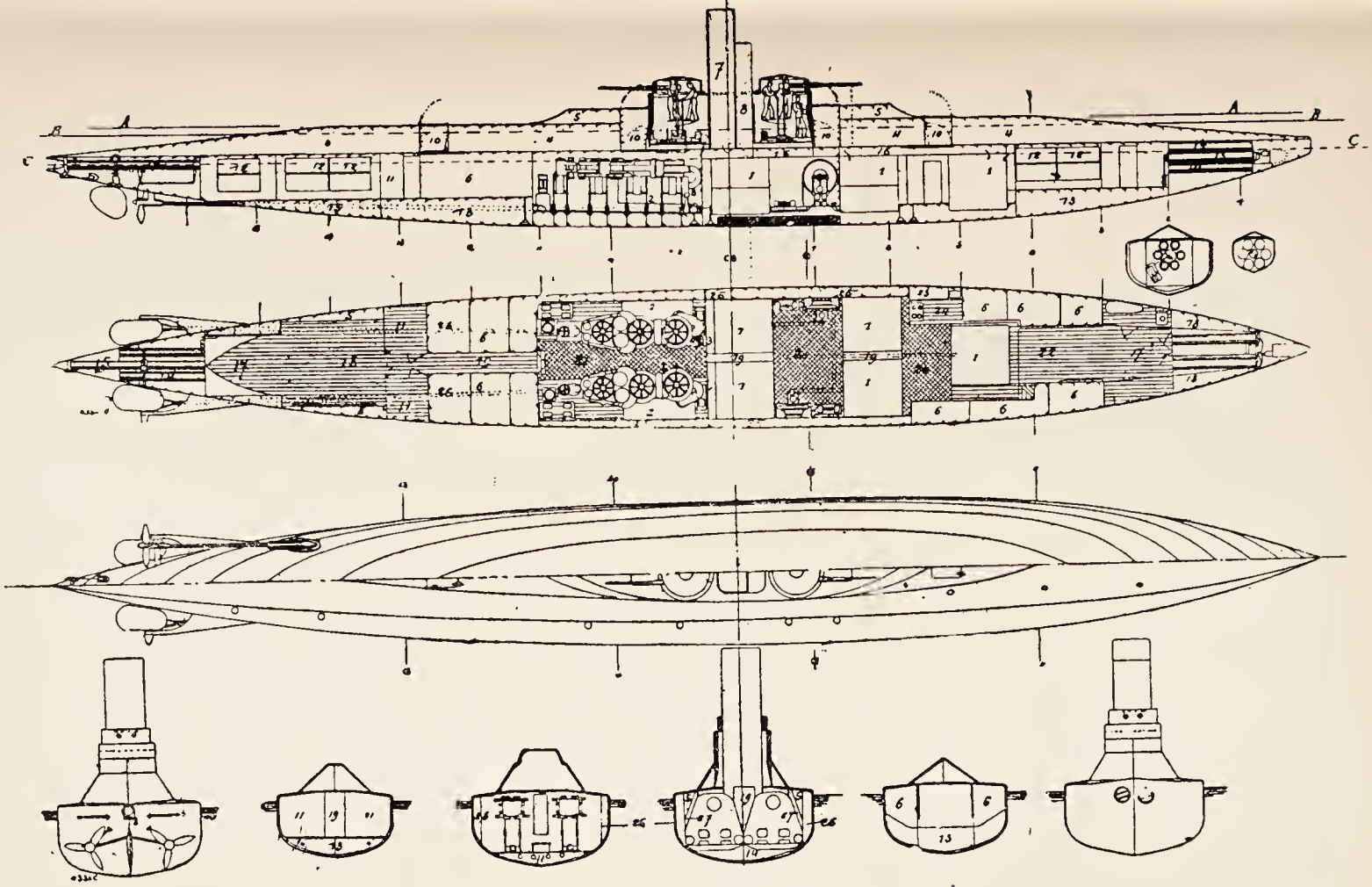
The armament was to have consisted of three torpedo tubes,—two side by side in the bows, and one in the stern, and for these tubes five White head torpedoes would be carried. On the deck is a steel armoured turret 4 feet high to protect the operator, the rest of the hull would be covered by 3 feet of water when the vessel is running awash. On this turret are placed two smaller armoured turrets fore and aft of the smoke-stack, and each of these contains a small quick-firing gun. The mode of attack is as follows: When the boat is running on the surface of the water with full steam power and it becomes necessary to dive quickly, the pilot gives the order 'Prepare to dive,' the oil fuel is instantly shut off from the furnace and the valves are opened to admit water to the water ballast tank; an electric motor draws down the smoke-

stack and air shaft into the superstructure and moves a large massive sliding panel over the aperture of the turret through which the smoke-stack passes. These operations would take about 30 seconds to complete when the boat is in the awash condition and prepared to dive. In 20 seconds more it will be running horizontally at a depth of 20 feet below the surface. Although the 'Plunger' was actually launched on August 7th, 1897, she was never completed, although for three years various alterations of detail were carried out. The steam engines were removed and were replaced by oil motors. But by the time these modifications had been effected, the 'Holland Torpedo Boat Company' came to the conclusion that the 'Plunger,' when completed, according to the plans of the contract, would be so inferior to the 'Holland' and 'New Hollands' that they offered to refund the Government all it had paid them upon the 'Plunger' and all expenses connected with the contract, and consented to the loss of that amount, provided the Department would contract with them for a 'New Holland.' The Secretary accepted their proposition, and they refunded to the Department the sum of $94,364.68, made up of the following items:

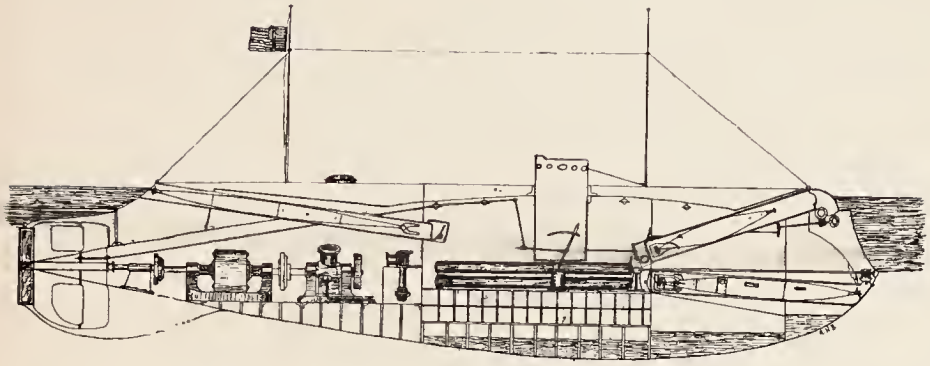
Partial payments on 'Plunger'	$89,730 . 00
Two bow torpedo tubes	1,800 . 00
Air compressor from Bliss and Co....	1,500 . 00
Advertising	1,334 . 68
	$94,364 . 68

Holland No. 8.

The eighth vessel designed by Mr. Holland was destined to be the forerunner of a large class. An illustration of this vessel is appended, and it will be seen that she carries as armament, one submarine torpedo tube, one tube for aerial torpedoes and a submarine dynamite gun. Alterations were made, however, the rudder being placed behind the propeller and the machinery shifted and from her was eventually developed the 'Holland No. 9.'



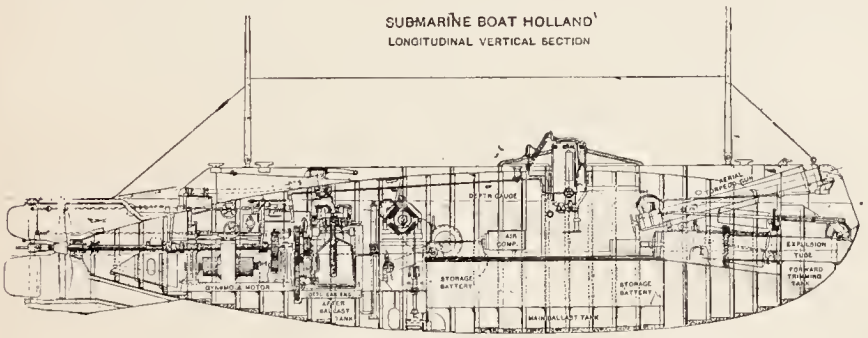
CLXXXVI.-CXCIV. PLANS OF 'PLUNGER II'



CXCV. PLAN OF 'HOLLAND NO. 8'

Holland No. 9.

Of this vessel perhaps more has been heard than of any other ship or boat in the world. She is the prototype of the latest submarines ordered by Great Britain and the American Government, and is also, without doubt, the commencement of the 'really successful' submarine. The following is the specification of the 'Holland No. 9':



CXCVI. 'HOLLAND NO. 9'

Length, over all	53-ft. 10-in.
Diameter (beam) frame No. 19	10-ft. 3-in.
Height, bottom to superstructure deck	10-ft. 7-in.
Displacement, submerged	74.3/10 tons

Hull.

All transverse sections circular. Plating of steel laid in

eight strakes. Thickness, 6/20-in. forward, 7/20-in. amidship, 5/20-in. aft.

Seams — Longitudinal seams, double staggered riveted lap joints, steel rivets.

Butt joints planed, with double riveted steel straps, 15-lbs. per square foot, steel rivets.

Circumferential seams, plating to frames, single riveted, liners under outside strakes.

Frames — 3½-in. x 3-in. x 6.7-lbs. steel angles, from frames five to thirty inclusive. Remaining frames 3-in. x 2½-in. x 5.6-lbs. Spacing 18-in.

Stapling — And deck beams, 2½-in. x 2½-in. x 5-lbs. steel angles.

Bulkheads — Steel plate, 15-lbs. per square foot, forward and aft; others 10-lbs. per square foot. All sufficiently braced for the purposes of the ship.

Deck Plates — Of steel, 15-lbs. per square foot for machinery and armament spaces. Floors with reverse framing at each frame under machinery and battery spaces. Deck under expulsion tube having floors sufficient for the needs of the ship.

Tanks — Of steel plate under decks and at sides of ship, consisting of ballast tanks, to bring when filled, the ship to an awash condition; forward and after trimming tanks, forward tank for gasolene, and compensating tanks for weights received or expended are provided.

Storage battery being installed in steel tank.

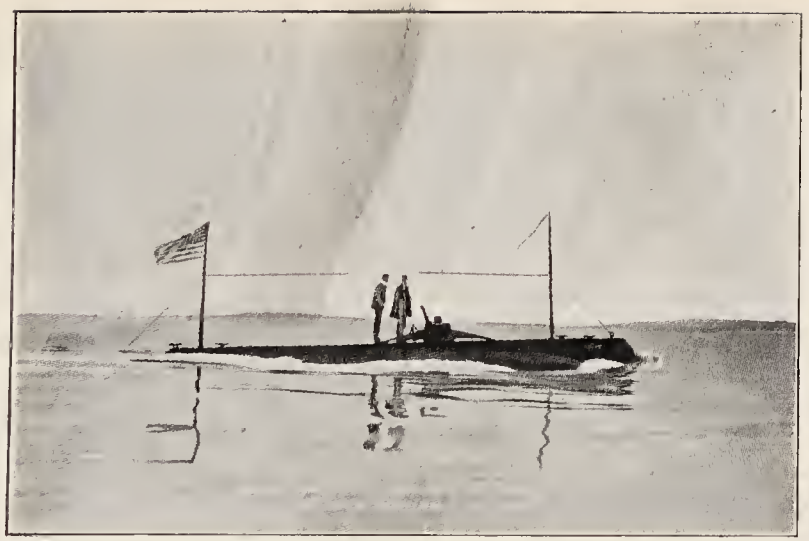
All of sufficient strength and stiffness for the purposes of the ship.

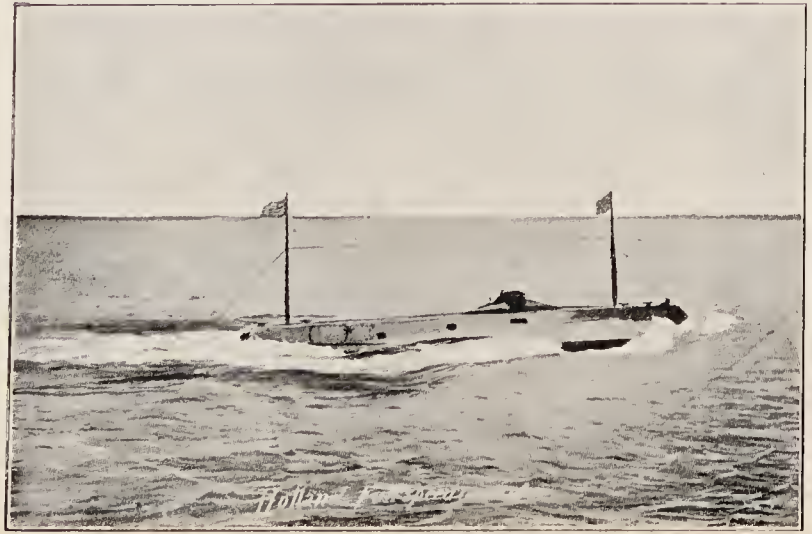
Manholes are provided for access to the various tanks.

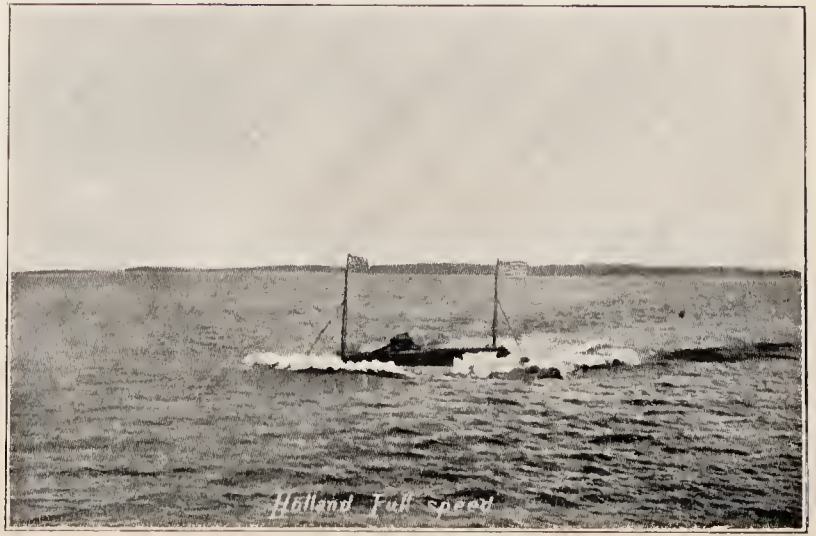
Superstructure — Of steel plate, 7½-lbs. per square foot, with frames of 2½-in. x 2½-in. x 5-lbs. steep angles, spaced 36-in. apart. A clear deck space is provided 37 feet in length; greatest width 3 feet 7 inches with ample cleats for mooring the ship, and locker for anchor and chain.

Scuppers are provided, of sufficient area to allow superstructure to fill quickly.

Rudders — Two sets are provided; a pair in a vertical plane, for horizontal steering; a pair in a horizontal plane for diving and rising, all constructed of steel, 10-lbs. per square foot, two plates to a rudder, sufficiently braced, and posts of ample strength for extreme angles of movement.







CXCVII.-CC. FOUR VIEWS OF 'HOLLAND' AFLOAT

Skegs

Of steel plates, with stiffening and supporting angles, of sufficient strength to carry the rudders and their posts in all positions of movement.

Conning-Tower

Of bronze, one inch in thickness, with a clear opening in top, 18 inches diameter, closed by a hinged cover, closing against a rubber gasket, and secured by a toggle locking device.

Ports or peepholes, covered with plate glass are provided, arranged to allow observation by the navigator in all directions.

Conning-tower arranged to allow of installation of telescopic section, with means of raising or lowering.

Forward End

Of steel, of sufficient strength for the purposes of the ship. Collision bulkhead located at frame No. 29.

Masts

Of steel, trussed, spaced 30 feet apart; height 9 feet 6 inches above deck of superstructure, arranged to allow observation of movements of vessel when submerged to small depths.

Propulsion.

Screw Propeller

Of cast iron, 4 feet 5 inches diameter, 2 feet 9 inches pitch, left hand; driven by steel shaft, 4 inches diameter. Speed 300 revolutions per minute.

Main Engine

Otto, gasoline type, with double cylinders, each single acting, giving a total of 45 horse-power at 340 revolutions per minute, and consuming about one pint of gasoline per horse-power per hour.

Gasoline tank, frames 22 to 29, has capacity of 1,050 gallons, allowing a run of ship for 185 hours at full speed, this being 6 miles per hour with this power.

Main Motor

Electric; water-proof type, of 50 horse-power (nominal) with two commutators. Capable of developing 160 horse-power, giving the ship a speed of 8 knots. Speed of motor 900 revolutions per minute.

Motor arranged to operate propeller shaft, or, driven as a dynamo, to charge storage battery.

Gearing

From motor to propeller shaft, and engine to propeller shaft, provided with suitable clutches to allow the following combinations: Engine to propeller; engine to dynamo (motor);

motor to propeller; motor to engine (for starting engine). All gears covered with sheet iron cases.

Bearings

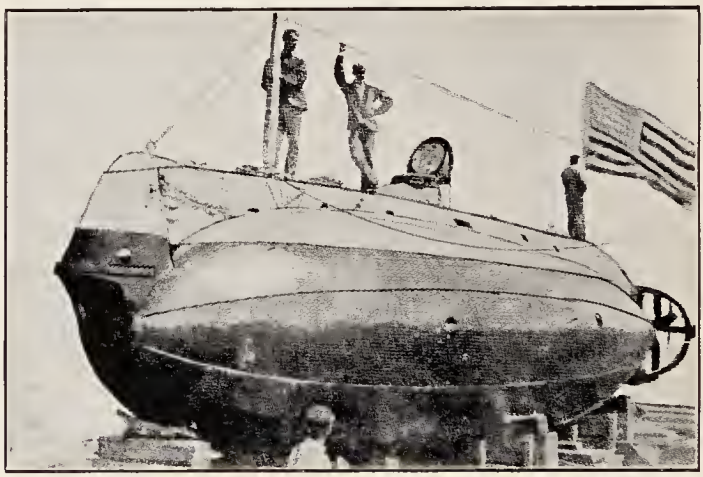
Of ample length for continued running; stern bearing of lignum vitæ, others babbited or bushed with bronze. High speed shafting, provided with self-oiling bearings.

Electric Storage Battery

Sixty cells, with a capacity of 900 ampere hours under normal rate of discharge. Installed in steel tank, between frames 14 and 24. Battery may be charged by main dynamo or from supply outside of the vessel.

Switch-boards and Switches

Are provided, together with safety appliances, to control the current used for power and lighting. Main motor provided with controller and 'field rheostat.' Auxiliary motor provided with starting rheostat.



CCI. THE 'HOLLAND NO. 9;' BOW VIEW

Electric Wiring

Of best insulated wire, installed with view of insulating system from the hull of the ship. In no case is the hull used as a return on a circuit.

Lighting System.

Arranged to distribute light to various points of the ship. Portable incandescent lamps being used.

Ballasting and Trimming System.

Comprises a series of water tanks, one located at each extreme position, forward and aft, for longitudinal trim, and

ballast tanks amidship of sufficient capacity to change the ship from the position for surface running to that awash, with a portion of the conning-tower emerged, this being the condition for diving. Means are provided for blowing the water from the tanks outboard, by air, or by pumping. Outboard communication from tanks secured through 8-in. and 4-in. Kingston valves, opening outward against the pressure of the surrounding water, and operated by levers in the ship. Valves have ample area to quickly fill or empty these tanks; all tanks with outboard connections are of sufficient strength and stiffness to withstand the pressures of extreme depths, if the valves be opened at these depths. All tanks having for part of their bounding surfaces the plating of the ship, are provided with cemented bottoms, up to the height of the webs on the frames.

Compensation.

For torpedoes is provided, to keep trims of the ship constant at all times.

Gasoline Tank.

Is fitted with suction float, and necessary index of quantity of gasoline carried.

Compensation is provided to preserve the trim of the ship during consumption of gasoline.

Air Supply.

One low speed compressor, driven through gearing, by an electric motor of 10 horse-power, furnishes air at 2,000-lbs. pressure per square inch, to welded steel storage tanks 13/16-in. thickness. These tanks have a combined capacity of 22 cubic feet.

All tubing for this system, of steel, and connections of sufficient strength for this pressure.

A supply at lower pressure is secured through a tested automatic, reducing-valve, with double diaphragms, supplying storage tanks at 50-lbs. pressure; one having capacity of 4¼ cubic feet for operation of machinery; and two with an aggregate capacity of 5½ cubic feet for expulsion of torpedoes.

Low pressure tanks, 10-lbs. per square inch, are provided for blowing out ballast and trimming tanks, and emptying torpedo expulsion tube.

Pumps.

One Bilge pump is provided, geared to and operated through clutches, by the 10 horse-power motor, driving the air compressor. Through suitable connections this pump will empty any or all tanks, in addition to the bilges.

One small hand-pump is provided to empty the storage battery drip-tank, the latter being located to free the tank of any fluid.

One duplex, air-driven, reciprocating piston fluid pump, to operate steering and driving engines, exhausting its air into the interior of the ship.

Piping.

Of suitable strength for the pressures used; with all necessary valves and connections to secure quick manipulation of the various systems.

Steering and Diving.

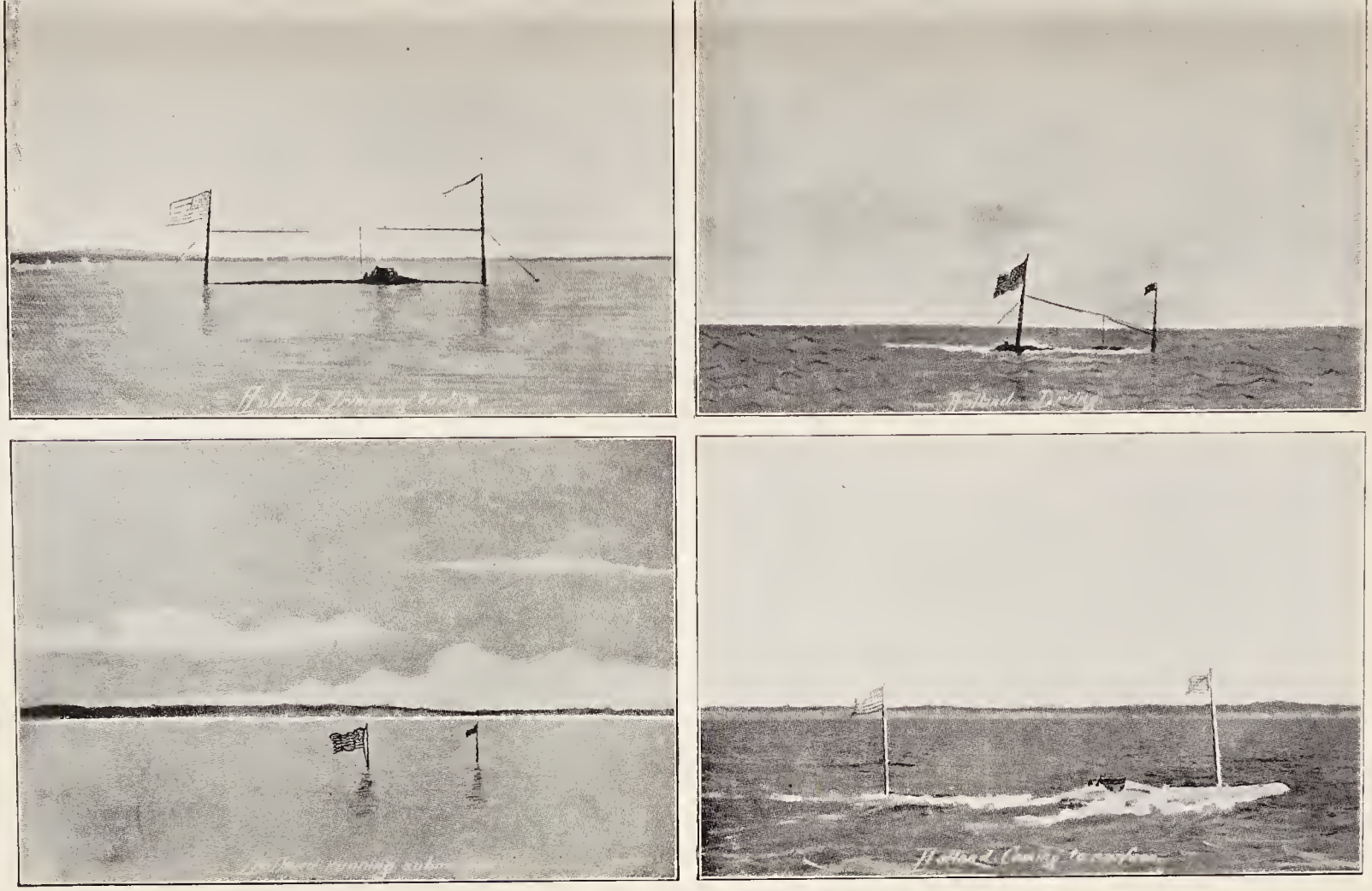
Engines are provided with reciprocated pistons attached directly to the leads. Cylinders are of sufficient size to provide quick movement to the rudders.

Motion of pistons so regulated, that rudders are locked in the desired positions.

Through a series of connections, the navigator controls the steering and diving engines from the conning-tower.

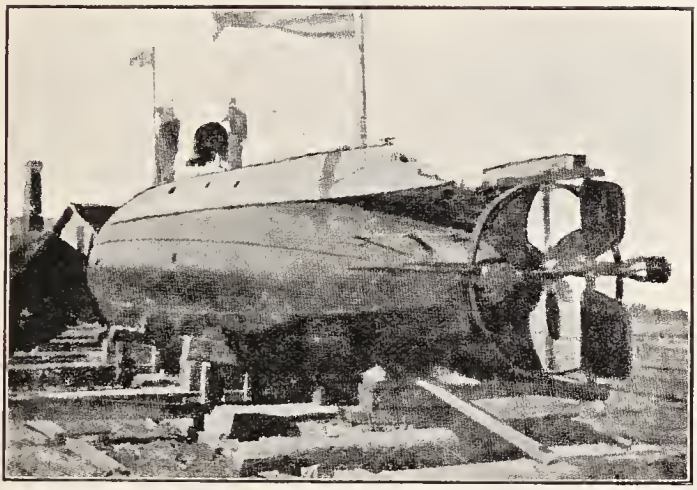
Hand operation of each of these engines secured by turning a valve.

The diving engine is provided with an automatic device, to govern the controlling valve; a diaphragm to keep the ship at a constant desired depth; a pendulum device to maintain a horizontal position, and apparatus to bring the ship from an inclined or diving position to a horizontal position at a predetermined depth; this being accomplished by reversing the



CCII.-CCV. FOUR VIEWS OF 'HOLLAND' DIVING

diving rudders, to a rising position during the period of diving, at a time previous to reaching the desired depth; reaching this depth cuts out this reversing mechanism, leaving the ship under the control of the diaphragm and pendulum until a time when the navigator desires to rise or proceed to a greater depth.



CCVI. THE 'HOLLAND NO. 9;' STERN VIEW

Gauges.

And indices are provided to record all conditions of the ship; pressure and depth gauges, clinometers, etc., are provided.

Ventilation.

The exhaust of the air-operated machinery is distributed throughout the ship; connections to storage tanks are arranged to allow a supply of air into the boat, at will. Several openings are arranged to provide the interior of the boat with outside air when at the surface. The engine space is provided with ventilator, with electrically driven exhaust fan; openings in conning-tower at end of gun, and several port openings allow a circulation of air through the ship.

Excessive pressure of atmosphere in the interior of the ship is relieved through a safety valve installed for this purpose.

Exhaust gases from the main engine, are carried through

a water jacket, directly to the outside of the ship and lead aft to exhaust boxes, at the stern.

Navigating Apparatus.

Is supplied for all of the operations of the ship. The conning-tower being provided with rudder indicators for steering and diving rudders; clinometer for transverse and longitudinal trims; whistle cord, for outside signal whistle, bell pulls and speaking tube for communication with engine room, and other parts of the ship. The compass is conveniently placed in the conning-tower and at all times is visible to the navigator.

Gauges for depth of ship, pressure in pipe systems, and quantities of water in tanks are situated at suitable points. The gasoline tank having a special gauge.

Armament.

Consists of one 'lower deck tube, Type 2, for 45cm. x 11-ft. 8-in. White-head torpedo,' constructed after the plans of the Bureau of Ordnance. This is placed at the extreme forward end of the ship, opening outboard, 3 feet below the light water-line. The cap is hinged, lifting upwards and operated by worm gearing from inside of the ship. Cap makes a water-tight joint when closed against a rubber gasket.

Air at 50-lbs. pressure per square inch is used for expulsion of torpedoes. Ten pounds per square inch being used to empty expulsion of tube of water.

The ship has a capacity for carrying three 45cm. x 11-ft. 8-in. White-head torpedoes, and means of compensating for each and every one.

One bow gun with fixed elevation for aerial discharge of high-explosive shells. Projection secured through varying combination of compressed air and explosive powder.

The ship and all its apparatus have been thoroughly and continuously tested and operated; extremes in speed having tested the strength and durability of the propulsive machinery; extremes in depth having tested the strength of the hull, all tanks and valves connected outboard; this is coupled with the tests of an experimental model, constructed to measure the

resistance of such a hull to collapse at great depths; extremes in steering testing the strength of the machinery for that purpose repeated expulsion of torpedo testing the tube and its devices, and the operation of all of the above apparatus, to a degree of fineness, hitherto unknown in navigation and engineering.

Holland No. 10.

After exhaustive trials with 'No. 9' which is commonly known as the 'Holland' the Government purchased the vessel on April 11th, 1900, for $150,000. The experiments subsequently carried out (and recounted further on) proved so very successful that in the act for making appropriations for the fiscal year ending June 30th, 1901, which was approved on January 7th, 1900, the following item appeared:

'The Secretary of the Navy is hereby authorised and directed to contract for five submarine torpedo boats of the 'Holland' type of the most improved design, at a price not to exceed one hundred and seventy thousand dollars each: *Provided*, That such boats shall be similar in dimensions to the proposed new 'Holland,' plans and specifications of which were submitted to the Navy Department by the Holland Torpedo Boat Company, November twenty-third, eighteen hundred and ninety-nine.

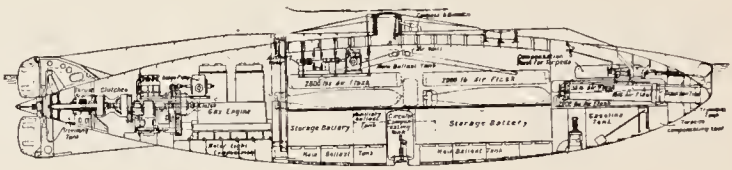
'The new said contract and submarine torpedo boats covered by the same are to be in accordance with the stipulations of the contract of purchase made April eleventh, nineteen hundred, by and between the Holland Torpedo Boat Company, represented by the Secretary of the said Company, the party of the first part, and the United States, represented by the Secretary of the Navy, the party of the second part.

'Toward the completion of the equipment outfit of the new vessels heretofore authorized, four hundred thousand dollars.'

This number was carried to six and they were given the names 'Adder,' 'Grampus,' 'Mocassin,' 'Pike,' 'Porpoise,' and 'Shark.' Of these the 'Grampus' and 'Pike' were built at the Union Ironworks, San Francisco, the remaining four at Lewis Nixon's shipbuilding yard. The Holland Com-

pany at the same time laid down a speculation boat of the same type which has been named the 'Fulton.'

The following is the specification of the new boats, which resemble those being built for the British Government in the main features, though differing in detail.



CCVII. PLAN OF 'HOLLAND NO. 10'

Length, over all	63-ft. 4-in.
Diameter (beam), frame No. 21	11-ft. 9-in.
Height, bottom to superstructure deck	12-ft. 1-in.
Displacement, submerged	120 tons (salt water)

HULL.

All transverse sections circular. Plating to be of steel laid in ten strakes. Thickness to be 7/20-in. forward, 8/20-in. amidship, 7/20-in. aft.

Seams — Longitudinal seams, double staggered riveted lap joints, steel rivets.

Butt joints planed, with double riveted straps, 17½-lbs. per square foot, steel rivets.

Circumferential seams, plating to frames, single riveted liners under outside strakes.

Frames — 3½-in. x 3-in. x 7.8-lbs. steel angles from frames 8 to 31 inclusive, other frames 3½ x 3 x 6.6-lbs. steel angles. Spacing 18 inches. Stapling, 2½-in. x 2½-in. x 5.9-lbs., steel angles.

Bulkheads — Steel plate, 17½-lbs. per square foot, forward and aft. All sufficiently braced for the purposes of the ship.

Deck Beams — 3-in. x 3-in. x 6.1-lbs., steel angles for machinery spaces; 2½-in. x 2½-in. x 5.9-lbs. under expulsion tube.

Deck Plates — Of steel 17½-lbs. per square foot for machinery spaces; 15-lbs per square foot for forward deck under expulsion tube.

Floors — With reverse framing at each frame in machinery and battery

spaces and installed two frame spaces apart under expulsion tube.

Tanks

Of steel plate to be placed under decks, and at sides of ship. System comprises forward and after trimming tanks, main ballast tanks, separated by a longitudinal bulkhead; auxiliary ballast tanks, etc., and gasoline tanks, for storage of gasoline for main engine. Storage battery to be installed in water-tight steel tank.

Manholes

To be provided to allow access to all tanks.

Super-structure

Of steel plate, 10-lbs. per square foot with frames 2½-in. x 2½-in. x 5.9-lbs., steel angles, spaced 54 inches apart. A clear deck space to be provided, 31 feet 6 inches in length, greatest width, 4 feet 5 inches, with ample cleats for mooring ship. Superstructure to have locker for anchor and chain. Scuppers to be provided of sufficient area to allow superstructure to fill quickly.

Rudders

Two sets to be provided, one pair in a vertical plane, for horizontal steering; one pair in a horizontal plane for diving and rising. All construction of steel, 10-lbs. per square foot, of double plates, braced by arms from the rudder posts.

Posts

To be of forged steel of sufficient strength to allow a large margin of safety against accident when subjected to excessive stresses.

Skegs

Four in number, to be of steel plate, combined to provide ample stiffness to carry the rudders and their posts. Skegs to be securely anchored to hull of the ship, and braced and tied horizontally and vertically, to form one complete structure.

An additional brace and separating member to be provided, consisting of a steel ring, which is also to serve as a shield for the propeller.

Conning-Tower

To be of armour steel, circular, 4 inches in thickness, with a clear opening in top, 21 inches in diameter, closed by a hinged cover of steel, and made water-tight against a rubber gasket, by a toggle locking device.

Ports or peep holes to be provided, arranged to allow observation in all directions. Ports to be covered with plate glass, with means of closing port in event of breakage of glass, thereby preventing flow of water into the boat, if submerged.

To be securely fastened to the hull, giving a resistance to impact of projectiles equal to the full value of the armour.

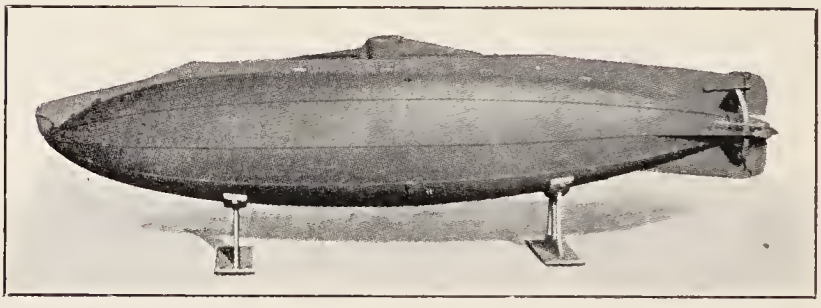
Forward End — To be provided with two bulkheads, these combined with the structural strength due to the form of the hull, to give sufficient margin of safety in event of collision.

Hatches — To be provided of ample size for torpedoes and machinery parts.

In General — Hull to present no projecting parts for entanglement with ropes, etc., while submerged.

Propulsion.

Main Engine — To be of Otto, gasoline type, with four cylinders, each single acting, balanced to prevent excessive vibration. Horse-power to be 160, at 340 revolutions per minute, consuming about one pint of gasoline per horse-power per hour.



CCVIII. MODEL OF 'HOLLAND NO. 10'

Gasoline tank to have capacity of 6,850 gallons.

Speed of ship, with main engine at full power to be 8 knots per hour.

Main Motor — To be electric, water-proof type, of 70 horse-power (nominal), giving the ship a speed of 7 knots per hour, when awash or submerged. Speed of motor, 800 revolutions per minute.

Gearing — To be provided to allow, through clutches, the following combinations:—Main engine to propeller, main engine to motor (in this case, motor to be driven as dynamo, to charge storage battery), motor to propeller, motor to engine (for starting engine).

Propeller

To be left hand, and driven by steel shaft, 4 inches in diameter, through gearing before mentioned. A suitable clutch to be installed to disengage propeller shaft during the charging of the battery.

Bearings

Stern and thrust bearings to be constructed according to the best practice. Inboard shaft bearings of sufficient length for continuous running.

High-speed bearings to be self-oiling.

Electric Storage Battery

To comprise 60 cells of 'chloride' type, to have a capacity of 1840 ampere hours under normal rate of discharge, and a capacity to furnish 75 horse-power for three hours at 120 volts.

Battery to be arranged to receive charge from main dynamo (motor) in the ship, or from supply outside and independent of the ship. Battery to be positively insulated from the hull or parts thereof.

Switch Boards and Switches.

To be installed together with all safety appliances for the safe and efficient distribution of electric current throughout the ship. Motors to have proper rheostats located in the best positions for manipulation.

Auxiliary Motor.

Of 10 horse-power to be provided for operating bilge pump.

Electric Wiring.

To be installed with a view to safety and to minimize magnetic effect on the compass. In no case is the hull used as a return on a circuit.

Lighting System.

To be arranged to distribute light to all portions of the interior of the ship. Portable incandescent electric lamps to be located at necessary points.

Ballasting and Trimming System.

To consist of a series of tanks filled with outboard connection as follows:—For longitudinal trim, one tank located

at each extreme position forward and aft, these to be combined, and with the addition of other means, to make trimming or ballasting automatic.

Compensation.

To be provided for all weights expended or received, keeping trims of the ship constant.

Air Supply.

To be provided, one air compressor, driven through gearing by main engine or by main motor. To furnish air at 2,000-lbs. per square inch to welded steel storage tanks, with a total capacity of 69 cubic feet. Supply at lower pressure to be obtained from 2,000-lb. tanks, through reducing valves, operating automatically.

At 50-lbs. pressure to be used for expulsion of torpedoes, operating machinery and manipulating trimming system.

At 10-lbs. pressure to empty ballast tanks, etc.

Pumps.

Two rotary pumps to be installed, one to be driven by auxiliary electric motor of 10 horse-power. One to be driven through gearing by main motor, or main engine, as desired.

One small hand-pump to be provided to empty storage battery tank drip-reservoir.

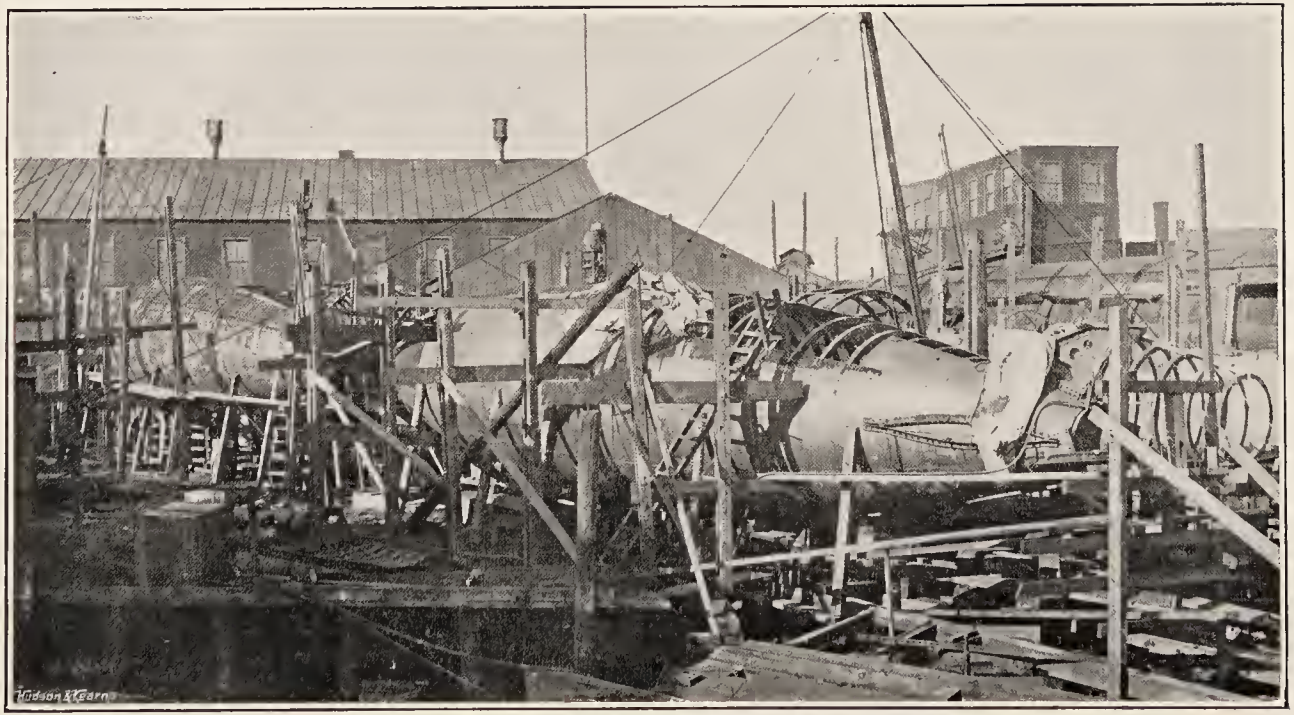
One duplex reciprocating pump to operate diving and steering engines.

Piping.

To be of suitable strength for the pressures used in the various systems, arranged to allow of connections from either of the rotary pumps to each and every tank located in the ship.

Steering and Diving.

Engines to be provided with reciprocating pistons attached directly to the leads. Cylinders of sufficient diameter to pro-



By favour of the 'Navy & Army Illustrated'

CCIX. SUBMARINE BOATS UNDER CONSTRUCTION AT LEWIS NIXON'S YARD

vide quick movement to the rudders to extreme angles of movement.

Pistons to be locked through the operations of the controlling valve in all desired positions.

Through a series of connections, steering and diving engines to be under control of the navigator in the conning-tower.

Hand-operation of either engine to be secured through by-pass valve.

Diving engine to be provided with automatic devices to maintain the ship in a horizontal position, to secure a constant depth during submergence; to reverse the diving rudders to a rising position at a depth less than the desired depth, thereby bringing the ship from an inclined or diving position to one horizontal, at the desired depth at which time the ship is to be placed under the control of the automatic devices for maintaining the desired depth and a horizontal position, until such a time as the navigator desires to rise, or dive to a greater depth.

Gauges.

To be provided to provide visual means of determining all conditions of the ship; these to consist of depth, ballast, oil, and air-pressure gauges, and all necessary appliances for determining the trim of the ship.

Ventilation.

To be provided through exhaust of air-driven machinery, distributed throughout the interior of the ship; by providing means of allowing flow of air from the low-pressure storage tanks.

Ventilators, with electrically driven fans, to be installed over engine and at other suitable points to allow of complete ventilation of the ship when on the surface.

Openings, consisting of hatches, conning-tower opening and necessary ports in hull, to be located for inflow of outside air.

Excessive air pressure in the interior of the ship to be relieved through safety valves for that purpose.

Exhaust gases from the main engine to be led directly from the ship through water-jacketed piping, then carried aft under superstructure to the stern.

Navigating Apparatus.

To be supplied, ample bell-pulls, speaking-tubes, etc., for communication from the navigator to various points in the ship. Whistle and side-lights to be located on the exterior.

Compasses to be furnished in duplicate, one located outside of the hull, with means of observation from the interior of the conning-tower. One to be located in the interior of the conning-tower. Both to be visible at all times, to the navigator.

Armament.

To consist of one torpedo expulsion tube, to be constructed after the plans of the Bureau of Ordnance. To be placed at the extreme forward end of the ship, opening outward two feet below the light water-line.

Cap to be hinged, lifting upwards and operated by an air cylinder, or by hand, at will from the interior of the ship. To make a water-tight joint when closed, against a rubber gasket, and locked securely by powerful toggle lock.

Interlocking apparatus to be proved to prevent attempted expulsion of torpedo if outboard cap be closed, or in event of accident at the moment of expulsion. Interlock to prevent opening of the breech at times when the expulsion tube is opened into the sea.

Air, at a pressure of 50-lbs. per square inch, to be used for expulsion of torpedoes.

Ship to have capacity for carrying, storing and discharging five 45cm. x 11-ft. 8-in. White head torpedoes and means of of compensating for each and every one.

Modifications.

Changes in the plans submitted for armament, to be possible. Either one or two expulsion tubes can be installed, provided they be in a vertical plane.

Type of expulsion tube may be recommended by the purchasers.

The following pages give some account of the trials of the

'Holland' and the opinions of a number of important naval men, with some of the correspondence that has taken place between the Government and contractors.[1]

HOLLAND TORPEDO BOAT COMPANY.

100, Broadway,
New York City,
November 23, 1899.

Sir,

We append to this letter copies of the Acts of Congress approved March 10, 1896, and March 3, 1899, marked 'A' and 'B,' authorizing you to contract for two submarine boats similar to the submarine boat Holland. We also append copy of your letter to the Chairman of the Committee on Naval Affairs of the United States Senate, dated February 28, 1899, marked 'C,' recommending the passage of the Act approved March 3, 1899, and would state that this letter was read in the Senate and the Act passed in accordance with your recommendation.

We now submit for your consideration the following propositions:

1st. We will sell to the Department, under the authority conferred upon you by the Act approved March 3, 1899, the submarine boat Holland as she stands for the sum of One hundred and sixty-five thousand dollars ($165,000). Your Board of Inspection and Survey has inspected and reported favourably on this boat, after the last official trial made before said Board by your order. We append a copy of the Board's report, marked 'I.' Specifications of this boat were filed with the Board of Inspection and Survey. We append copy of the same to this proposal marked 'N.' We are prepared to change the dynamite tube in the 'Holland' to a torpedo tube, in accordance with the plans submitted herewith, marked 'O.' This was deemed advantageous by several members of the

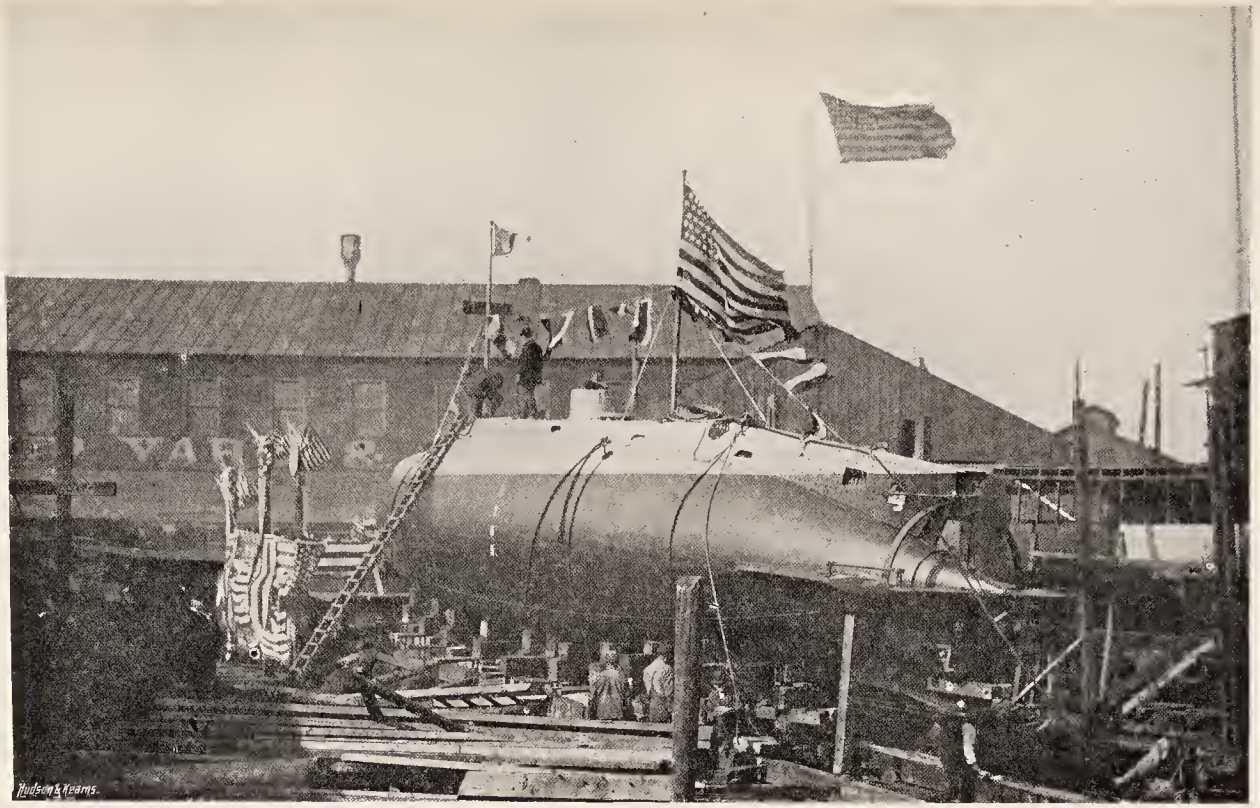
1 I am able to reproduce these letters by the courtesy of Messrs. Vickers, Sons and Maxim.

Board of Inspection and Survey, as it gives the 'Holland' two torpedo tubes for immediate use in action instead of one. If the change is desired by the Department the price of the 'Holland' will be increased to One hundred and seventy thousand dollars ($170,000).

2nd. We propose to build the second boat, authorized by the Act of March 3, 1899, in accordance with the plans and specifications submitted herewith, marked 'P.' These plans and specifications give, as the Department will perceive, a larger boat than the 'Holland,' with a number of other improvements that have been made upon the 'Holland' designs. The price of this boat, built according to plans and specifications herewith, will be One hundred and seventy thousand dollars ($170,000).

The reasons for offering the 'Holland' for sale as one of the two boats authorized by the Act of March 3, 1899, is fully set forth in the report of Captain John Lowe, Chief Engineer, U.S.N., made you under date of November 7, 1899, copy appended marked 'K.' Your orders to him are enclosed, marked 'J.' We also append copy of report of Chief Engineer John Lowe, dated November 14, 1898, marked 'M,' made in accordance with your letter to him, dated June 25,1898, marked 'L.' Should the Department for any reason deem it not expedient to purchase the 'Holland' as one of the two boats authorised by the Acts of June 10, 1896, and March 3, 1899, then we offer to the Department to build two boats instead of one, under the plans and specifications submitted herewith, in accordance with the second proposal submitted in this letter, for the sum of One hundred and seventy thousand dollars ($170,000) each, to be delivered in four months from the date of the signing of the contract by this Company, as the law requires.

Upon careful investigation we have decided that, taking all the various phases of the problem into consideration, the maximum amount of power that can be utilized when submerged will be 50, and when running light 150 horse-power. We have, therefore, provided these respective powers and are prepared to guarantee them. Our estimates as to the speeds which will be obtained under these conditions is 7 knots submerged and 8 knots light. After a careful balancing of the



By favour of the 'Navy & Army Illustrated'

CCX. THE 'SHARK' READY FOR LAUNCHING

advantages to be obtained, it is our opinion that it is not wise to attempt to put more power into a boat of these dimensions with the present types of motor available.

Your attention is called to the letters of the Department of May 3, marked 'D,' and of June 15, 1898, marked 'E,' and also to that of November 4, 1898, marked 'F,' all enclosed herewith, directing the Board of Inspection and Survey to inspect and report upon the trial of the 'Holland.'

Your attention is called especially to the report of the Board of Inspection and Survey, marked 'G,' upon the 'Holland's' performance in connection with the recommendation of the Board of Construction contained in Department's letter of June 15, marked 'E,' enclosed herewith, by which it will be seen that on that trial a large number of requirements of the Department were successfully fulfilled. Your attention is also earnestly called to the report of the Board of Inspection and Survey, dated November 9, 1899, marked 'I,' in which the Board unanimously report that all the requirements of the Board of Construction, set forth in its letter of June 15, have been fulfilled and that 'A thorough inspection of the plans and the vessel was made, and the Board was impressed with the excellent condition of the boat and of all its appliances.'

We take this opportunity to state to the Department why it was that we, at such an enormous expense of money and time, decided to build the 'Holland.'

Our plans of the 'Plunger' were sent to the competition opened by the Naval Department in 1893 for designs for a submarine boat, and they were accepted. A delay of a few years having occurred, and in the meantime a closer study of the designs having been made it became apparent that these plans were not the best. At the request of Secretary Herbert, the matter was submitted to him, but we substituted a new design, which was not accepted by the Department. We were, therefore, compelled to construct the vessel under the original plans. During the progress of the work on her designs in the drafting room a great many very objectionable features were encountered. It was very clear to us that even though the 'Plunger' could fulfil the guarantee she did not represent the highest development of a submarine boat. Our Company, therefore, determined to construct at its own expense what

appeared to it to be a perfect design and to exhibit it later to the Government. The result is the 'Holland.'

In order to comply with the requirements of the Department, as laid down by the Board of Construction and endorsed by yourself, we have been experimenting, altering, changing, and improving the 'Holland' for the past two years, paying our engineers and the trained crew, and in other ways endeavouring to meet the Department's requirements, at an enormous expense to the Company. We are gratified, therefore, to show the Department that we have been able to fulfil all of its requirements, which, up to this time have not been accomplished by any other submarine boat in the world.

With reference to the completion of the 'Plunger,' we are awaiting your authorization to remove the present motive machinery from her and substitute other power, that we know from experience will be far more suitable and make of the 'Plunger' the efficient vessel she was originally intended to be. The changes in the 'Plunger' are to be made without any expense to the Government.

Very respectfully,

HOLLAND TORPEDO BOAT COMPANY,

Secretary.

Honorable John D. Long,
Secretary of the Navy,
Washington, D.C.

'A.'

Acts of Congress authorizing the Secretary of the Navy to contract for Two Submarine Torpedo Boats similar to the submarine boat Holland.

'The Secretary of the Navy is hereby authorized to contract for the building of two submarine torpedo boats of the Holland type, at a cost not exceeding One hundred and seventy-five thousand dollars each; said boats to be constructed and delivered to the Navy Department within four months from the date of contract; *Provided* That the Holland boat now being built for the Department shall be accepted by the Department as fulfilling all the requirements of the contract,

and as being satisfactory to the Secretary of the Navy; but no action shall be taken therein until said Holland boat now being built for the Department shall have been fully tested to the satisfaction of the Secretary of the Navy, and thereupon accepted.'

Act approved June 10, 1896, page 379, vol. 29, Statutes at Large.

'B.'

'The Act of June tenth, eighteen hundred and ninety-six, authorizing the construction, in the discretion of the Secretary of the Navy, of two submarine boats, is hereby amended so as to permit the Secretary to contract for two submarine boats of the Holland type, similar to the submarine boat Holland.'

Act approved March 3, 1899, page 1,039, vol. 30, Statutes at Large.

'C.'

Letter of Secretary of the Navy recommending the last Act to be passed.

Navy Department,
Washington,
February 28, 1899.

Sir,

Acknowledging the receipt of your letter of the 27th instant, enclosing a copy of an 'amendment intended to be proposed by Mr. Stewart to the bill (H.R. 12122) making appropriations for the naval service for the fiscal year ending June thirtieth, nineteen hundred,' I have the honor, in response to your request for the views of the Department with regard to the proposed amendment, to submit the following statement:

Under date of November 4, 1898, the Department appointed a board for the purpose of inspecting the submarine torpedo boat 'Holland.' While the report of the inspection made by the board so appointed was, with respect to many features of the operation of the 'Holland' as a submarine boat, favorable,

it was not altogether satisfactory and the board recommended that a further examination of the qualities of the vessel be made.

The vessel thus inspected and reported upon—the 'Holland'—was built by the Company; is, it is understood, a more modern boat than the submarine boat 'Plunger,' and is probably better in all respects. Although smaller, the 'Holland' is less complex in her machinery and is constructed according to plans involving less expense than those upon which the 'Plunger' was built.

In view of the foregoing, the Department perceives no objection to the adoption of an amendment authorizing the two submarine boats already provided for to be made of the 'Holland' type, but is not prepared to say that three are necessary until further trial. It is of opinion that the conditions respecting the satisfactory construction and performance of the boats embodied in the Act of June 10, 1896, should be explicitly described. It is, however, believed that the limit of cost, $175,000 each, as fixed in the original Act, should certainly not be exceeded, and that it might, in all probability, be reduced. It is observed that the amendment contains no specific provision upon the point of cost.

A press copy, already in the possession of the Department, of the report of the Board of Inspection above mentioned, is herewith transmitted for the information of the Committee, the copy being transmitted in that form in order to avoid the delay of recopying.

Very respectfully,
(Signed) JOHN D. LONG,
Secretary, S.C.L.

Hon. Eugene Hale,
Chairman Committee on Naval Affairs,
United States Senate.

(Enclosure.)

'D.'

Letter of Secretary of the Navy Prescribing Tests for the Holland.

Navy Department,
Washington,
May 3rd, 1898.

Gentlemen,

(1). The Department has considered the various reports that have thus far been made regarding your submarine torpedo boat, which you have recently offered for sale to the Government.

(2). While these reports are in many respects favorable, it is evident that in several essential particulars, certain parts of the mechanism have worked imperfectly, and the working of other parts has either not been demonstrated or has not been functioned to the satisfaction of the Inspectors who were ordered to witness the trials of the boat.

(3). The Department is, however, willing to witness further trials when you are prepared to make them, and will order a Board of Naval Officers for that purpose if you so desire.

(4). Among the points which must be successfully exhibited, in order that the Department may consider the idea of purchase, are the following:

Ability to run awash at good speed; ability to dive and to rise readily and with certainty; ability to run under water at depths from 10 to 35 feet, at a speed of about six (6) knots per hour; the boat holding a reasonably steady course, both in the vertical and horizontal planes during said runs, which are to be each not less than ten minutes in duration; ability to turn both to starboard and to port with reasonable quickness and certainty; the steering gear being managed without too much effort, and conveying readily and with certainty the movements of the steering wheel to the rudder; the mechanism for controlling the diving apparatus to be equally efficient and satisfactory; the mechanism for raising and lowering the boat in the water, and for altering her trim, must be also efficient and certain in its action; the apparatus for insuring a steady course during the run, both above and below water, must be reasonably simple and also certain and efficient in its action.

(5). The Board will be directed to ascertain accurately the rate of speed both above and below water, as well as the steadiness of movement in the horizontal and vertical planes; and the facility of turning with the diameter of the turning

circle, etc.; and for these purposes you must be prepared with staffs or other suitable devices to enable the Board to determine the position of the boat during her submergence.

(6). The boat must be strongly constructed, the material and workmanship of all parts the best of their respective kinds, and the efficient performance of the torpedo discharge apparatus must be demonstrated to the satisfaction of the Board by one or more discharges of torpedoes adapted to each kind of tube, mounted on board; and such torpedoes as you propose to furnish yourselves must function satisfactorily during flight, and must explode with certainty at the proper time.

(7). The Department will furnish service White-head torpedoes, which your Company must discharge successfully and efficiently through the tube you have provided for that purpose.

(8). It is to be understood that all parts of the torpedo discharge apparatus shall be thoroughly practicable and efficient, and that the boat complete, and her armament, shall be efficient practical, and adapted to the uses of submarine warfare, including the means of supplying air inside during the whole time that she may be used to effect a submarine operation in war.

(9). If you desire to have this trial made, you will please so inform the Department promptly, stating the time you will be ready to exhibit the boat to the Board.

Very respectfully,

JOHN D. LONG,
Secretary.

The John Holland Torpedo Boat Co.,
25, Pine Street, New York City, N.Y.

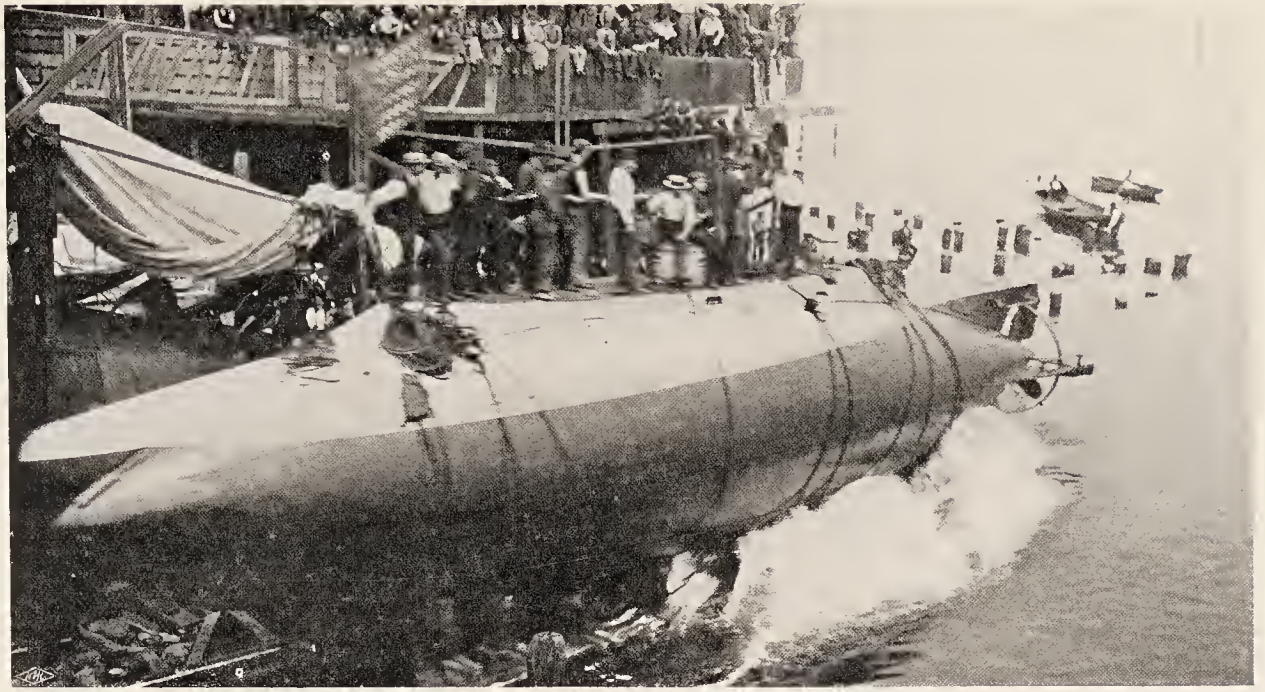
'E.'

Recommendation of Board on Construction of Tests for the Holland.

Navy Department,
Washington,
June 15, 1898.

Sirs,

Referring to your letters of May 28th, June 6th, and June 11th respectively, relative to further tests of the submarine boat



By favour of the 'Navy & Army Illustrated'

CCXI. LAUNCH OF THE AMERICAN SUBMARINE 'SHARK'

'Holland,' I have to inform you that the several letters above mentioned were referred to the Board on Construction, and under date of the 14th instant the Board reports as follows:

'In view of the fact that the Department, by its letter of May 3, 1898, to the Holland Torpedo Submarine Boat Co., informed the Company that it was willing to witness further trials of the Holland Submarine Boat, and would order a Board of Naval Officers for that purpose, if desired by the Company, and in view of the fact that the Holland Boat company in its letter to the Department of May 28, 1898, having informed the Department that it expected to be ready to submit the boat for further trial to the Department within ten days, but requesting certain modifications in the lengths of the staffs to be carried by the boat during certain conditions of the trial, and further requesting that a member of the Board be ordered to go down in the boat in her next trial. The Board on Construction has the honor to recommend that when the Company fixes a definite date on which the boat will be ready, the Department will order a Board of Naval Officers to witness such tests as the Company is prepared to make, and on account of their familiarity with the subject, it is suggested that the members of the former Board be again ordered. The Board recommends that the requests of the Company as to staffs, be granted, viz.: 'not to be more than eleven feet long, and to be taken off when submerged runs for speed are made, and when the boat is to be submerged more than ten feet, and to be removed altogether when the boat is to be tested for accurate steering.' It is not recommended that a member of the Board be ordered to go down in the boat, as her safety is not an assured fact, but the Board sees no objection to any Naval Officer going down in her, who desires to do so. The Board does not recommend that the Department furnish projectiles for the guns of the Holland boat, being of the opinion that the Company should supply its own projectiles, or dummies of proper size and weight to demonstrate the efficiency of the aerial torpedo guns. The Bureau of Ordnance informs the Board that it is ready to supply a White-head torpedo at any time the Company will signify that it is ready for it, but as, so far as known, the Company has no means of charging the air flask of the torpedo, it should not call for the torpedo

until it is needed. In addition to the requirements specified in the Department's letter of May 3, 1898, to the Holland Company, all of which should be adhered to, except as herein modified, the Board is of opinion that the boat should at least show her ability to make a surface run of eight nautical miles, followed by a submerged run of two miles, and a return on the surface of ten miles. Her radius action should be ascertained both on the surface and submerged. She should carry food and water for her crew for at least 24 hours. She should be able to receive on board, in a reasonable time, and without difficulty, a service torpedo. Her ability to re-charge her storage battery by means of her own dynamo and gas engines should be ascertained. In case of accident to her machinery she should be able to anchor and get under way. The approximate range of her aerial guns should be ascertained. The question of habitability for the crew is of great importance, and it should be determined whether a crew could remain in her long enough to conduct reasonable operations without undue hardships. The Company should be given to understand distinctly that the Department is to be under no expense on account of this test, aside from furnishing a White-head torpedo for use during the same, and moreover, that by consenting to witness further tests, the Department in no way commits itself as to its further actions concerning the Holland submarine boat.

The Department approves the foregoing report and recommendations of the Board on Construction, together with the additional requirements to those specified in the Department's letter of May 8, 1898, to the Holland Torpedo Boat Company, all of which shall be adhered to, except in so far as the latter have been modified by the above report of the Board.

As soon as the Department is informed that a definite date has been fixed by your Company on which the 'Holland' will be ready for further trial, it will consider the question of ordering a Board of Naval Officers to witness such tests as the Company is prepared to make. It is to be distinctly understood, however, that the Department is to be at no expense on account of said tests, aside from furnishing the White-head torpedo for use during the same, nor does the Department, by consenting to witness such further tests, in any way commit

itself as to its future action concerning the Holland submarine boat.

Very respectfully,
JOHN D. LONG,
Secretary.

The Jno. P. Holland Torpedo Boat Co.,
141, Broadway, New York City.

'F.'

Orders for Board of Inspection and Survey.

Navy Department,
Washington,
November 4, 1898.

Sir,

The Board of Inspection and Survey, of which you are the Senior Member, is hereby ordered to assemble at such place as may be selected by the Holland Torpedo Boat Company, at 10 a.m. on the 12th instant, for the purpose of inspecting the Submarine Boat 'Holland.' You will proceed to such place as may be designated and assemble the Board on the date specified.

Upon the completion of this duty, return to Washington, D.C., and resume your present duties.

Place yourself in communication with Mr. E. B. Frost, the Treasurer of the Company, 141 Broadway, New York, N.Y.

A list of the officers, who have been aboard this vessel during the submerged runs, is herewith enclosed for the information of the Board, and, in case consultation with any of them is desired the Department will issue the necessary orders if requested by you.

Respectfully,
JOHN D. LONG,
Secretary.

Captain Frederick Rodgers, U.S.N.,
President Board of Inspection and Survey,
Navy Department,
Washington, D.C.

'G.'

Report of Trial of 'Holland' Submarine Boat.

Navy Department,
Board of Inspection and Survey,
Washington, D.C.,
November 12th, 1898.

Sir,

1. The Board appointed by the Department's order of November 4, 1898, for the purpose of inspecting the submarine boat Holland, has the honor to make the following report:

2. A copy of the above mentioned order is herewith appended marked 'A.'

3. In obedience to the provisions of this order, the Board after preliminary arrangement with the Holland Company, was convened at 10.30 a.m., on November 12, 1898, at Pier A, North River, New York,—Present, all members and the recorder—and immediately embarked on a tug which transported them to the foot of 50th Street, South Brooklyn, where the Holland was lying moored to dock.

4. The Board decided that the first item on the programme for the day should be the firing of a torpedo. A White-head of 17.7 inches was placed in the tube by means of a cage lowered from the dock and thus introducing the torpedo from the outside, an awkward but necessary arrangement. The time required was 20 minutes for placing the torpedo in the tube, 20 minutes for draining the tube and torpedo, and 4 minutes for charging. The torpedo was charged for 1,000-lbs. and set for 5 feet. The placing and charging of the torpedo was superintended by Lieutenant W. J. Sears, U.S.N., who had come from the Bliss Torpedo Factory for that purpose. There was considerable delay in making the adjustments, etc., partly on account of the lubricating oil being frozen, and partly because the rear end of the torpedo tube is so near the deck that when the torpedo is pulled inboard the tail piece takes against the deck. This should be remedied.

5. At 12.45 p.m. the Holland shoved off from the dock and started down the harbor, followed by the tug containing the members of the Board. On board the Holland were five

members of her crew, Chief-Engineer John Lowe, U.S N., Naval Cadet H. J. Elson, U.S.N., and Lieutenant Nathan Sargent, U.S.N., the recorder of the Board, this making eight souls in all. The boat started out under an electric motive power and on the surface of the water, that is, having only her natural submersion, under which circumstance her conning-tower and about 18 inches of the upper framework built so as to afford a flat footing above the round hull, was out of water. At 12.56 the torpedo was fired with a pressure of 50-lbs. and with the boat underway at a speed of some 5.3 knots, the electric motor at the time making 275 revolutions. The torpedo ran near the surface and with several breaches, for a distance of some 300 yards, and was picked up by a launch sent for the purpose.

6. At 1.50 after some slight difficulty in getting the engine started, the Holland went ahead under her gasoline engine, which was used until 2.20, when Princess Bay, near Sandy Hook, was reached. During this run the engine made about 300 revolutions, equal to a speed of 6 knots.

7. Preparations were now made for diving by submerging the boat, some twenty minutes being occupied in filling the forward, main and after tanks and in getting the boat in proper trim for diving. This length of time was due to the inexperience of the man running the boat and not to any trouble with the mechanism which functioned perfectly, the tanks being filled in the space of one minute for each. The motive power was now changed from gasoline to electric.

8. From 2.40 to 3.10 a number of dives were made, ballast shifted or water blown from tanks or let in, with the view of putting the boat in proper trim for a long dive, the duration of the dives being as follows:

1st	dive	1	minute		
2nd	dive	2	minutes		
3rd	dive	0	minutes	15	seconds
4th	dive	4	minutes	15	seconds
5th	dive	4	minutes	15	seconds
6th	dive	0	minutes	30	seconds
7th	dive	0	minutes	40	seconds
8th	dive	10	minutes	20	seconds
9th	dive	0	minutes	20	seconds

10th	dive	0	minutes	10 seconds
11th	dive	2	minutes	35 seconds
12th	dive	4	minutes	10 seconds
13th	dive	4	minutes	10 seconds
14th	dive	1	minute	10 seconds
15th	dive	0	minutes	15 seconds
16th	dive	0	minutes	50 seconds
17th	dive	0	minutes	15 seconds
18th	dive	0	minutes	30 seconds
19th	dive	0	minutes	30 seconds

The maximum depth attained in diving was 15 feet, and in the long ten minutes dive an even depth of 7 feet was maintained for the greater part of the time. The boat decidedly proved her ability to dive, but much time was wasted in balancing her preparatory to diving, and when this began it was noticed that the boat broached often. Both of these objectionable features were evidently due to inexperience on the part of the crew. The boat is caused to dive and come up by the action of her horizontal rudders, which are moved by a compressed air steering engine. If the valve of this engine is delicately manipulated, the boat, if properly trimmed, should be kept at a desired depth without trouble, but the tendency of all inexperienced operators would be to feel a little nervous as the boat inclines downward, and to reverse the valve too rapidly, thereby bringing her up again with a rush. This was the case in this trial, but can easily be remedied by experience. The maximum inclination was 12 degrees by the head and 3 degrees by the stern.

9. After the ten minute dive Lieutenant Sargent left the Holland and his place was taken by Commander W. H. Emory, U.S.N., the junior member of the Board.

10. At 3.57, the diving being finished, the water was blown out of the forward and main tanks and at 4.11 the boat started homeward under her gas engine, arriving off her dock about 6 p.m.

11. The consumption of electricity from the storage battery was shown by fall of voltage from 124 at start to 118 at finish. The lowest point to which it is desirable to go with the battery is 104 volts., so that enough voltage was left for four hours

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CCXII. THE 'SHARK' AFTER THE LAUNCH

more run, and in an emergency this could have been exceeded. The time for recharging the storage battery—which is done by means of the gasoline engine and dynamo—is from eight to ten hours.

12. During the time—from 12.20 to 3.22—that the boat was submerged for diving, the scuttle of the conning-tower was necessarily hermetically closed, but for this whole hour the air seemed perfectly good, it being refreshed from time to time by the discharge of air from the exhausts of the steering and diving engines.

13. The boat seems to steer wildly. Whether this is due to sluggishness of the compass, which is very small, or to inexperience on the part of the man in the conning-tower, could not be determined.

14. With regard to the requirements for the Holland as laid down by the War Board and the Bureau of Construction at various times, the Board met on Sunday, the 13th instant, heard the testimony of Chief Engineers Lowe and Zane, Lieutenant Sears, Naval Cadet Evans, all of whom had been down in the boat, and considered the experience of the trial the day before. From all of the above they concluded as follows, upon the classes of the different requirements:

I. Ability to run awash at good speed, established.

II. Ability to dive and rise readily and with certainty established.

III. Ability to run under water at depths from 10 to 35 feet at 6 knots, the boat holding a steady course both in the vertical and horizontal planes during said runs, which are to be each not less than ten minutes in duration, not established. Steering was very erratic and boat unable to maintain position under water for more than a few minutes at time. We believe, however, that this was owing to inexperience of crew.

IV. Ability to turn both to starboard and port with reasonable quickness and certainty, steering gear working well, etc., the mechanism for controlling the diving apparatus to be equally efficient and satisfactory. The boat turns quickly, but the steering and diving gear did not work satisfactorily, owing, we believe, to the inexperience of the crew.

V. The mechanism for raising and lowering the boat in the water and for altering her trim, worked satisfactorily and was certain in its action.

VI. The apparatus for insuring a steady course during the run below water was not used. That for securing a steady course on the surface worked very satisfactorily.

VII. Rate of speed above water about 6 knots.
Rate of speed under water about 4 knots.

VIII. Steadiness of movement in horizontal and vertical plane, unsatisfactory.

IX. Facility of turning, good. Tactical diameter not ascertained.

X. The boat is strongly constructed. Torpedo discharge appears satisfactory.

XI. Air supply was good and ample.

XII. Boat was able to make surface run of reasonable length, and we believe can be made to run under water 4 to 5 miles, though she failed to do 2 miles on this trial.

XIII. Radius of action both on surface and submerged, we believe to be satisfactory.

XIV. She can carry food for crew for twenty-four hours.

XV Can discharge service torpedo.

XVI Ability to recharge storage battery by means of her own dynamo and gas engine, satisfactory.

XVII. Ability to anchor satisfactory.

XVIII. Range of aerial gun not ascertained.

XIX. Men can remain on board for reasonable time.

15. In view of the fact that from want of practice in handling the boat and the torpedo in connection with it, the company was not prepared to comply with the requirements of the Board, it is recommended that another trial be made under more systematic conditions, with a trained crew, with more preparations for the trial properly made beforehand, and particularly with the following details carried out:

(A) Have three torpedoes in place.

(B) Have all arrangements made for charging torpedoes without delay.

(C) Be prepared to fire torpedo at full speed when submerged as well as when at full speed on surface.

(D) Having crew exercised by actual practice so as to be

able to make required submerged runs and steer a straight course. In order to make a trial submerged run of two miles, it is recommended that two marking buoys be placed in lower or Sandy Hook Bay a mile apart, and that a boat to serve as torpedo target be anchored near one of these buoys, so that the Holland after running a mile under water can come up to surface for observation, discharge her torpedo and then diving again can return to first buoy. This would complete her two mile under-water run. A measure of her efficiency will be shown by the number of times it is necessary for her to come to the surface for observation.

(E) The buoys necessary for the above runs could readily be placed in proper positions before the trial by the Light House tender of the New York District.

Respectfully,

(Signed) FRED'K RODGERS,
Captain, U.S.N., Pres. of Board;
(Signed) CIPRIANO ANDRADE,
Chief Engineer, U.S.N., Mem.;
(Signed) R. D. EVANS,
Captain U.S.N., Mem.;
(Signed) W. H. EMORY,
Commander, U.S.N., Mem.;
(Signed) N. SARGENT,
Lieutenant, U.S.N., Recorder.

The Secretary of the Navy.

'H.'

Letter of Secretary of the Navy with recommendation of Board on Construction as to test of 'Holland.'

Navy Department,
Washington,
June 27th, 1899.

Sir,

The Department received your letter of the 19th instant referring to the report of the Board of Inspection and Survey on the trial of the submarine boat 'Holland,' which took place November 12th last, particularly to clause 15 of the said report,

recommending that another trial of the 'Holland' be made under more systematic conditions, with a trained crew, etc., and requesting that, in accordance therewith, the Board of Inspection and Survey be instructed to witness and report upon the further trials, of the 'Holland,' which will take place within the next thirty days.

In reply I have to inform you that under date of the 12th instant, the Board of Inspection and Survey referred to the Department your letter of the 19th instant, asking that the trial course of the submarine torpedo boat 'Holland' be laid out in Little Peconic Bay and suggesting that such course be laid out by a trained Surveyor, whose certificate or affidavit would be considered sufficient evidence of its exactness. Having referred your letter to the Board on Construction for recommendation, the Board reports as follows:

'The Board on Construction is of the same opinion as that expressed in the first endorsement hereon by the President of the Board of Inspection and Survey, namely, that the within request is a reasonable one and that Little Peconic Bay is a suitable place for the trial; and it is recommended that the request be granted in case the Department decides to order any further inspections of the submarine boat 'Holland.'

'A certificate from the Surveyor who lays out the course as to its exactness (in case it is done) might be accepted, the Department reserving the right to verify the course, if it chooses.'

On the 20th instant the Department informed the President of the Board of Inspection and Survey that, in view of the foregoing report of the Board on Construction, the Board was authorized to witness the contemplated submerged trial of the 'Holland,' but that the Department would not issue any orders to the Board directing an inspection of the vessel while submerged, although any individual members of the Board were at liberty to make such inspection, if they voluntarily desired to do so.

Very respectfully,

JOHN D. LONG,
Secretary.

Mr. E. B. Frost,
Secretary, Holland Torpedo Boat Co.,
No. 100, Broadway,
New York City, N.Y.

SUBMARINE NAVIGATION

'I.'

Final Report of the Board of Inspection and Survey.

Navy Department,
Board of Inspection and Survey,
Washington, D.C.,
November 9, 1899.

Sir,

(1). In obedience to the Department's order of November 3rd, 1899, a copy of which is appended marked 'A,' the Board of Inspection and Survey has the honor to submit the following report on the trial of the Submarine Boat 'Holland' in Little Peconic Bay, Long Island, November 6th, 1899.

(2). The Board met in New London, Connecticut, on the afternoon of November 5th, and took passage in the Light House Tender 'Cactus' for Greenport, Long Island. This vessel had been placed at the service of the Board by the courtesy of the Light House Board.

(3). The representatives of the Holland Company met the Board in Greenport and the arrangements were made for the trial at 2.30 p.m. on November 6th.

(4). At 8.30 a.m. on November 6th, the Board left Greenport in the 'Cactus' and proceeded to New Suffolk, Long Island, where the 'Holland' was lying. A thorough inspection of the plans and of the vessel was made, and the Board was impressed with the excellent condition of the boat and all its appliances. At 12.45 p.m. the 'Holland' left the wharf at New Suffolk and proceeded to the course laid out.

Commander W. H. Emory, Member of the Board, went on board at the wharf and remained during the runs over the measured mile. Captain John Lowe, U.S.N., and six members of the crew were also on board; making a total of eight (8) persons in the boat during the runs. The President and the other members of the Board took passage in the Company's tender, and kept abreast the 'Holland' during the runs to note her behaviour and speed. At 2h. 28m. 05s., the 'Holland' made whistle signal that she was about to dive, and at 2h. 30m. 11s. disappeared, hull and conning-tower, beneath the surface and at 2h. 30m. 55s., she passed the buoy marking the beginning of the statute line. At 2h. 31m. 35s.,

she came to the surface, remained in sight (8) eight seconds, when she disappeared, and gradually assumed an even trim at a submergence of about five (5) feet, maintaining this trim and submergence without serious variations throughout the course. At 2h. 41m. 00s., when near the buoys marking the termination of the first mile, the vessel rose to the surface and changed course, first to port and then to starboard, heading for a target flag on the course. At the time of rising to the surface, the vessel was within the three hundred (300) feet channel marked by the buoys at end of course. At 2h. 42m. 00s., just before reaching the end of the mile, the torpedo was fired and the helm put hard-a-starboard, and headed for the return run over the course. This torpedo made a straight run and passed within seventy (70) feet of target and was recovered. At 2h. 43m. 12s., the vessel was again submerged, and at 2h. 49m. 45s., passed the half-mile buoys; at 2h. 52m. 50s., the threequarter mile station, and at 2h. 56m. 38s., completed the mile, having risen to the surface twenty-eight (28) seconds before reaching the buoys; being on the eastern edge of the three hundred (300) feet channel.

(5). Throughout the double run over the mile, the conning-tower was closed and the air within the vessel was quite fresh and pure. While on the course and submerged, it was very noticeable that the only disturbance of the water was due to the distance poles at each end of the boat. On one or two occasions, when the vessel dipped forward and the propeller came near the surface, the wake of the boat was quite noticeable, although the vessel itself was not in sight.

(6) After these runs Commander Emory left the boat, and Naval-Constructor Capps and Lieutenant-Commander Henderson went on board. One member of the crew was also sent to the tender, so that the weight carried was approximately the same as before. After closing the conning-tower instructions were given to prepare for firing a second torpedo at full speed The conditions at the beginning of this experiment were as follows: Torpedo tube full of water; two torpedoes on deck abaft tube, one centered on batten skids with tackle hooked ready to run torpedo into tube. Torpedo gate closed.

(7) At a given signal the air valves were opened and water

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CCXIII. THE 'ADDER' AT FULL SPEED ON THE SURFACE

forced from the torpedo into compensating tanks. The elapsed time from opening air valves to opening breech of torpedo tube was 4 minutes 45 seconds. Torpedo was in place in tube and breech closed in 1 minute 30 seconds. The tube was then filled with water from compensating tank in one minute. The outer gate of torpedo tube opened in 35 seconds. The total time consumed, from order to load to ready to fire, was 7 minutes 50 seconds. The vessel was then submerged to a depth of 5½ feet and a run at full speed and torpedo fired.

Time of submergence in test was 1 minute 20 seconds.

This torpedo came to the surface and disappeared about seventy-five (75) yards ahead of the boat and was not recovered. These torpedoes were charged to 1,325-lbs. pressure; range 400 yards and depth 5 feet.

(8) Log of the 'Holland' during this trial.

Voltage at start, 125.

12.45 p.m.—Start from wharf. Electric engine.

Cruising trim.

Commander W. H. Emory, Captain John Lowe, U.S.N., and six (6) members of crew on board.

One torpedo in tube, one amidships, and one in starboard wing.

12.48 p.m.—Substituted gas engine. Making for the course. Revolutions of the screw by gauge, 250.

Pressure in all air tanks, 2,100-lbs.

1.10 p.m.—Slowed down to 170 revolutions.

1.12 p.m.—Stopped and changed to electric engine.

1.14 p.m.—Closed conning-tower.

1h. 14m. 30s.—Ahead on electric engine.

1h. 23m. 00s.—Filled after tank.

1h. 25m. 00s.—Stopped.

1h. 27m. 00s.—Filled middle tank.

1h. 28m.30s.—Filled forward tank.

1h. 30m. 00s.—Went ahead.

1h. 30m. 30s.—Dive. Revolutions, 212.

1h. 37m. 00s.—Rose to surface and blew out amidships tanks.

1h. 43m. 00s.—Stopped. Turret open, awaiting arrival of consorts at course.

2h. 19m. 00s.—Start for official run.
2h. 26m. 00s.—Amidships tanks filled and conning-tower closed, and ran awash.
2h. 28m. 30s.—Dive. Revolutions, 226.
2h. 35m. 00s.—Got ready to fire torpedo.
2h. 41m. 00s.—Rose to surface.
2h. 42m. 00s.—Fired torpedo.
Turned and headed for return run.
2h. 43m. 12s.—The dive was made. Vessel steered well in both vertical and horizontal planes.
2h. 56m. 10s.—Rose to surface.
2h. 57m. 00s.—Open turret. Stopped.
Two air tanks down to pressure of 1,300-lbs.
Commander Emory and one of the crew left the boat. Their places were taken by Naval-Constructor Capps and Lieut.-Commander Henderson.
3h 20m. 00s.—Closed turret and went ahead awash.
3h. 35m. 00s.—Dive. Ahead full speed, and fired torpedo at submergence of 5½ feet. Rose to surface, and the members of the Board left the boat.

Maximum inclinations during these runs 10 degrees by the head, 9 degrees by the stern.

Voltage at start, 125. At finish after the surface run at 3h. 50m. p.m., 123.

Trial ended.

Requirements in Report of November 12, 1898.

(a) Have three torpedoes in place. Fulfilled.
(b) Have all arrangements made for charging torpedoes without delay. Fulfilled.
(c) Be prepared to fire torpedo at full speed when submerged, as well as when on the surface. Fulfilled. Torpedo fired when submerged at full speed.
(d) Having crew exercised by actual practice, so as to be

able to make required submerged runs and steer a straight course. In order to make a trial submerged run of 2 miles, it is recommended that two marking buoys be placed in lower or Sandy Hook Bay, a mile apart, and that a boat to serve as torpedo target be anchored near one of these buoys so that the 'Holland,' after running a mile under water, can come up to the surface for observation, discharge her torpedo and then diving again can return to the first buoy. This would complete her two mile under-water run. A measure of her efficiency will be shown by the number of times it is necessary for her to come to the surface for observation.

(e) The buoys necessary for the above runs could readily be placed in proper positions before the trial by the Light House tender of the New York District.

These requirements were fulfilled by the performance of the 'Holland' on this trial. The target used was a buoy instead of a boat.

The course was one statute mile in length, with a depth of four (4) to five (5) fathoms low water.

The ends of the course were marked by two buoys three hundred (300) feet apart, and each quarter-mile by buoys one thousand (1,000) feet apart, as shown in the accompanying sketch.

The performance of the 'Holland' during this trial showed a marked improvement, as compared with that of November 12, 1898. This development in the capabilities of the 'Holland' appears to have been reached:

(1). By re-arrangement of some parts of the machinery.

(2). Change of all the rudders to the usual position abaft the propeller, instead of forward of the latter, thereby much increasing the steering qualities of the boat in both planes.

(3). Adjustment of the compass, whereby the vessel was enabled to steer a straight course when under water.

(4). Drill and practice of the crew, resulting in their familiarity with all the duties assigned them, giving them confidence in the vessel.

(9). A copy of the 'Specification and Description of the

'Holland,' furnished the Board by the builders, is enclosed, marked 'C.'

A copy of Report of Trial of November 12, 1898, is enclosed, marked 'B.'

The sketch of the Course is marked 'D.'

Papers relating to the 'Holland' are herewith returned.

Very respectfully,

(Signed) FREDERICK RODGERS,
Rear-Admiral, U.S.N., President;
(Signed) W. H. EMORY,
Commander, U.S.N., Member;
(Signed) C. R. ROELKER,
Commander, U.S.N., Member;
(Signed) W. L. CAPPS,
Naval Constructor, U.S.N., Member;
(Signed) T. J. HENDERSON,
Lieut.-Comdr., U.S.N., Member and Recorder.

The Honorable, the Secretary of the Navy.

'J.'

WAM.
180609.

Navy Department,
Washington,
July 7th, 1899.

Sir,

Place yourself in communication with the Secretary of the Holland Torpedo Boat Company, 100 Broadway, New York, N.Y., for the purpose of being present at, and witnessing the trial of the Submarine Torpedo Boat Holland, to take place in the near future, and you will submit to the Department a report of your observations, together with notes on such matters of professional interest as may come under your notice

This duty is in addition to your present duties.

Respectfully,
JOHN D. LONG,
Secretary.

Captain John Lowe, U.S.N.
Member Naval Engineering Examining Board,
Philadelphia, Pa.
(Com'd't., League Island).
FSH.

'K.'

Report of Chief Engineer Lowe, on the 'Holland.'

Submarine Torpedo Boat Holland,
Holland Torpedo Boat Station,
New Suffolk, Long Island,
November 7th, 1899.

Sir,

In obedience to your order 180,609, July 7th, 1899; copy appended. On Thursday, July 13, I proceeded to this station and established communication with the Holland Company by presenting myself to its Secretary, Elihu B. Frost, Esq., and thereupon commenced a series of observations hereinafter described.

At this place are stationed and maintained a force of mechanics and draughtsmen as well as the Torpedo Boat Holland, with its crew and their understudies.

Near by, in Little Peconic Bay, is also maintained a trial and practice course two miles long, marked out and subdivided by flag poles upon each side and end.

Upon this course the Holland has made a large number of runs in both directions, all of them for the purpose of experiment, for the instruction of the crew and their understudies, and incidentally for exhibition purposes whenever convenient to all parties concerned.

Two of these runs are noticeable.

One on July 26th, 1899, before the Board considering alterations to the Plunger, on which occasion all members of the Board, in pursuance of their duty, made submerged trips.

The second was on October 6th, 1899, when two German Naval Officers were present, and one of them made the submerged trip, to be hereafter alluded to.

At all of these trials I was either present or else was fully cognizant of them and of their results, but of them I have made no report because being preliminary they could add nothing to the information of the Navy Department.

On August 30, 1899, Gunner Allan S. Mackenzie, U.S.N., reported for duty at this station, bringing with him three White-head torpedoes for use on board the Holland and for the instruction of the crew.

He has made several submarine trips in pursuance of his duty and all the success attained in handling these torpedoes is entirely due to him.

On Monday, November 6, 1899, the Official Trial of the Holland took place before the Board of Inspection and Survey, the following members being present: Rear-Admiral Frederick Rodgers, U.S.N., President; Commander Wm. H. Emory, U.S.N.; Commander Chas. R. Roelker, U.S.N.; Naval Constructor W. L. Capps, U.S.N.; Lieut.-Commander T. J. Henderson, U.S.N., Recorder.

The start from the wharf at New Suffolk was made at 12.45 p.m. with the electric engine. Present on board: Commander Wm. H. Emory, U.S.N.; Captain John Lowe, U.S.N.; and seven members of the crew, making nine persons in all, or four more than when going into a fight. There were three White-head torpedoes on board, to wit., one in the firing tube, one just abaft the tube, and the third in the starboard wing of the boat.

The following are the principal circumstances which took place within the boat:

Start, as before said, at 12.45 p.m. with the electric engine; substituted the gas or surface engine at 12.48 and made for the course. Revolutions 250. Stopped at 1.12 and substituted the electric engine. Closed the conning-tower and ahead at 1.14. Filled after ballast tank at 1.23; amidship tank at 1.27, and trimmed the forward tank to 3,225 pounds of water ballast, when the vessel was ready to dive; ahead at 1.30 and a dive made at 1.30 p.m. to 6½ feet, this being a preliminary dive before reaching the course, which was ended by rising to the surface and discharging the amidship tank at 1.27.

The vessel then, turret open and crew on deck, stood off-and-on awaiting the coming of the observation boat and other vessels until 2.19 p.m., when the turret was closed, the amidship tank filled and the vessel started awash at 2.26, then at 2.28:30 the vessel dived, and proceeded upon the course before described and the official trial commenced. Revolutions 226. Amperes 175 Volts 125. Observed that the movement of both helms was quite small, indicating complete equilibrium. While thus submerged the first torpedo was fired at 2.40:30. Discharge pressure 50 pounds per square inch. At 2.55:30

the vessel came to the surface, the amidship tank discharged and the vessel was brought to a stop at 2.56 : 30, the end of the course being reached. At this point Commander Emory left the vessel, and shortly afterward Lieutenant Henderson and Constructor Capps came on board. At 2.30 a new start was made awash. Stopped at 3.22 : 35 and loaded the torpedo tube with the second torpedo, which operation was finished and the vessel started at 3.28. Stopped and filled amidship tank at 3.29 : 40. Trimmed forward tank to 3,200-lbs. water ballast, when the vessel was in trim. Ahead at 3.34 : 05 p.m. Dive at 3.35 ; then while the vessel was at full speed submerged the second torpedo was fired at 3.37. The amidship tank was then discharged, the vessel brought to the surface, and stopped at 3.38 : 30, and Messrs. Henderson and Capps left the vessel. Afterward while in cruising trim the vessel made a short speed run, the beginning of which I lost by a faulty observation, but stopped at 3.50 p.m. 420 amperes at 123 volts was the output during the time. The trial was then declared to be at an end.

At the start the voltage was 125 and there were 6 air tubes filled with air to a pressure per square inch of 2,100-lbs. At the finish the voltage was 123 volts and two air tubes had the pressure lessened to 600-lbs. per square inch, leaving the four others intact.

The maximum inclination of the vessel in diving was 10 degrees by the head and 9 degrees by the stern.

The consumption of electricity was evidenced by a fall of (2) two volts. Remembering that 104 volts is the lowermost limit, it is evident that the vessel could have gone 10 times further than she did during this trial.

All movements of the vessel were made in obedience to the command of the President, Rear-Admiral Rodgers, U.S.N.

I greatly regret the fact that the crew of this vessel were not given the opportunity to exhibit themselves in one thing more to which they had been drilled, to wit : Allowing the vessel to sink to the bottom of the bay, and thus while entirely out of sight of any, either friend or enemy, while resting on the bottom, or loading the third torpedo in readiness for a third shot, and then leisurely making her appearance upon the surface again, to fire the third shot.

Throughout this trial the submergment could have been anything desired but care was taken not to entirely submerge the flags and poles because that would have rendered the vessel invisible to the Board. In real warfare these flags and poles would not be present at all and the vessel would be invisible even when lightly submerged.

Throughout the trial the air in the living spaces was entirely pure to breathe, being refreshed from the steering engines and from that used in discharging the trimming tanks.

In obedience then to that part of my orders requiring me to submit a report of my observation, I submit the facts hereinbefore stated, and I report my belief that the Holland is a successful and veritable Submarine Torpedo Boat, capable of making a veritable attack upon an enemy unseen and undetectable, and that, therefore, she is an Engine of Warfare of terrible potency which the Government must necessarily adopt into its service.

In obedience to the latter part of my orders, I add the following notes upon matters of professional interest, coming under my notice.

Concerning the worse than worthlessness of the present above-water Torpedo System, its methods, theories and appliances, the need for a deliverance from its absurdities and from the Fool's Paradise of its false securities, and instead thereof the absolute need of a real torpedo system such as the Submarine System I have already reported under date November 14, 1898.

Upon these topics I cannot now make better effort, therefore I ask that my old report be considered alongside of this one.

In addition, however, I would like to give further reasons why a Submarine Service should at once be organized as a matter of public necessity and security.

In the first place we must concede that, notwithstanding the Hague Conference, the time has not yet arrived for nations to disarm; on the contrary, that nation which is not ready to fight, that ceases to study war, that ceases to use the most frightful warlike appliances when war is made, has already placed itself in a position of inferiority and has ceased to possess those valuable attributes which are well described in

the term Manhood. Such a nation is already in the position of China, a prey to the weakest and the most rapacious, and a disturbance to all the rest of mankind.

If, then, we propose to fight, we must fight, when we fight, with every fighting appliance, and therefore, if there is anything valuable in Submarine Torpedo Warfare, we must not permit our hands to be tied behind our backs by any Hague Conference or pusillanimous humanitarianism forbidding such appliance.

Again conceding war to be possible, consider where the United States is weak and how to resist attack.

Let us not ostrich-like hide our eyes in the sand, but if we see danger let us look upon it.

We have distant dependencies, the Philippines, Hawaii and the like. Will an enemy seek to bring us to terms by attacking these? Perhaps so. But if so, the move would be a weak one, exceedingly weak. In fact, we could afford to offer these as a Gambit, upon which the enemy could waste its strength, while we were developing counter moves.

Let us not deceive ourselves. Any powerful enemy would not play at war after that fashion. They would strike us in the vitals. An eight-day dash across the Atlantic would bring their ships to Montauk Point, where they would encounter the American Fleet, which being destroyed by force of numbers, the remainder of the enemy's ships could pass on, and anchor in Long Island Sound in perfect security and very shortly Long Island would become a foreign possession.

Do not consider this scheme a fanciful one, it is not original to my mind. So many have spoken of it, that I am satisfied it has been considered and digested in foreign councils and is part of their programme.

Our last Spanish War convinced me that our own people were at that time awake to this fact, for we saw the Army diligently fortifying against what—PHANTOM SHIPS!

In our next war it won't be Phantom Ships, for there are at least two nations which can do this thing single handed.

We need right off and right now 50 Submarine Torpedo Vessels in Long Island Sound to preserve the peace and to give potency to our diplomacy.

The French in this matter are much more alive to their

needs than are we. What we have left to a private company the French have taken up as a National affair.

Leaving out the Gymnôte, of which I know but little, the French at the end of this year will have spent money and produced vessels as follows:

Gustave-Zédé	$586,181 00
Morse	166,483 00
Narval and class, 7 boats	910,000 00
Total.....	$1,462,664 00

In round numbers one and one-half million dollars.

It so happens, however, that the Zédé is only a partial success (newspaper accounts to the contrary notwithstanding), and the Morse still less so, while the Narval and class will be abject failures because of the same mistake made in our Plunger, a notable mistake which the Holland demonstrated in advance and which mistake I understand is to be rectified.

All the mistakes which have befallen the French will pass by our Government, notwithstanding the fact that instead of one and one-half millions our Government has not spent one cent, nor has it bestowed anything more than scant encouragement upon the private company which has spent large amounts of money.

Besides the mistakes saved, very many essential difficulties have been overcome which could not have been dreamed of at the outset, and as a consequence the Holland people by means of the Holland are in possession of ripe experience which the Government should possess, and no one else.

Among the facts stated in the first part of my report, I have described the Holland Torpedo Station and sketched the daily routine. I might observe that this is precisely what the Government would do did it possess a station of the kind. It is also precisely the routine to be observed by a Torpedo Boat at sea, lying in wait for an enemy. That is to say while motionless or in cruising trim, the batteries can be recharged and the air tanks filled ready for the approach of an enemy, until the fuel for the gas engine is nearly exhausted.

By favour of the 'Navy and Army Illustrated.'

CCXIV. THE 'ADDER' WITH CONNING-TOWER AND MAST ALONE SHOWING.

Of course this routine has produced the Holland and its crew, the one available as a school and practice vessel, the crew available as Drill masters, wherewith to leaven the entire Navy.

It seems to me, therefore, quite a necessity that this Government should not allow this skill and knowledge to pass out of its own hands from Native to Foreign Lands, but should forestall such a catastrophe by at once purchasing the Holland and putting the Holland people under some Ban whereby they will be prevented from disclosing secrets to the disadvantage of the United States.

How keenly Foreign Governments are alive to the Holland, I have shown in my facts herein reported, concerning the presence of Foreign officers upon her.

Concerning future improvements to be made in the Holland and her successors, I confine myself to one example to show how much this point is a matter of opinion and not yet of knowledge.

The Holland thus far has only one Torpedo Tube.

On the one hand, some advocate two such tubes and give good reasons; on the other hand, others argue that one tube only should be provided and give good reasons.

This, and several other alterations, can be made in the Holland either now or at any other time if so desired by the Government.

I desire to add my own opinion as to what the future policy of the Navy Department should be, after inaugurating a Submarine Service.

Instead of doing too much with one vessel, each one should be a distinct vessel of its kind, and not have combined two or more kinds in one vessel.

Thus, there should be Submarine Torpedo Boats; Submarine Gun Boats; Submarine Observation and Despatch Boats; Submarine countermines, and Submarine Channel Draggers, etc., each kind complete in itself, but not combining more than one office.

The object I have in mind is to keep the boats down to small dimensions for the sake of handiness and to keep each boat as roomy and as habitable as possible for the sake of the crew.

Further, it must be remembered that this class of vessel cannot possibly have the comforts of a roomy vessel. For example, there is no room for bodily exercise and recreation. There can be only limited cooking facilities. They must, therefore, always be attached to some base, either on shore or afloat, and then when sent on service the vessel and the crew must be considered analogous to an Army Scouting Party; they must carry food in their haversacks and water in their canteens. For sleep they will always be better off than soldiers are because they will always have a dry and a warm blanket and sufficient relief to get sufficient rest.

When the fuel for the engines is exhausted then food should be exhausted and the vessel should return to base, or the base to the boat for relief and replenishment.

All of which I have the honour to submit,

(Signed) JOHN LOWE,
Captain, U.S.N.

The Honourable Secretary of the Navy.

'L.'

WAM.

121826

Navy Department,
Washington,
June 25, 1898.

Sir,

You have permission to be present at, and witness, the trial of the Submarine Torpedo Boat 'Holland' to take place in the near future, and you will please submit to the Department a report of your observations, together with notes on such matters of professional interest as may come under your notice.

Respectfully,
(Signed) J. D. LONG,
Secretary.

Chief Engineer John Lowe, U.S.N.,
Continental Iron Works.

'M.'

Submarine Torpedo Boat 'Holland'
New York Yacht Club Basin,
Brooklyn,
November 14, 1898.

Sir,

1. On June 27th last, I had the honor to receive from the Navy Department the letter dated June 25th, 1898, of which a copy is appended.

2. The duty thus assigned me, I began June 28th by opening communication with the Holland Torpedo Boat Company.

On June 29 that Company placed this vessel and its crew completely at my disposition, and I made a complete examination of everything, putting all machinery in motion for the purpose.

I found the vessel complete in all but one detail, to wit, a defective breech plug to the Pneumatic Gun, which I was informed, was being replaced as rapidly as possible.

Pending this, I returned to my regular duty, but in addition I commenced making frequent visits to the vessel, so as to more fully prepare myself for the coming trial.

3. On July 19th, 1898, I witnessed a trial of the vessel in New York Bay, of which I made due report, under date July 19, 1898, a copy of which is appended, so as to make part of this report.

4. After this trial I was present at a number of trials, at which were also present and participating quite a number of Naval Officers, and others, more particularly Lieutenant Commander W. W. Kimball, U.S.N., Commanding Torpedo Boat Flotilla, besides other trials at which there was no other witness than myself. Upon one of these trials, the vessel went down and was submerged in 28 feet of water, and I took occasion to notice that her skin and framework were abundantly strong, there being not the slightest sign of distress in any part of her material.

Of these trials I made no report, because being of a preliminary nature they did not add to the information possessed by the Department.

5. On November 12th, 1898, I witnessed an Official trial

of the vessel, made before a Board of Naval Officers, composed as follows:

Captain Frederick Rodgers, U.S.N.; Captain Robley D. Evans, U.S.N.; Commander W. H. Emory, U.S.N.; Chief Engineer Cipriano Andradi, U.S.N.; and Lieutenant Nathan Sargent, U.S.N.

6. Of this trial I have the honour to report as follows:

After delay in charging a White-head Torpedo the Holland Torpedo Boat, left her wharf at 12.44 with her crew of five (5) persons on board, and also Lieutenant Nathan Sargent, Assistant Engineer Herman J. Elson, U.S.N., and myself, Chief Engineer John Lowe, U.S.N. These three observers were three more persons than would be in the vessel in a fight, and, therefore the vessel was handicapped to that extent. Driven by her electric engine at the rate of 275 revolutions, 5.5 knots at cruising trim, a White-head Torpedo was fired at 1 p.m.

At 1.10 after some difficulty, the electric engine was uncoupled and the Otto gas engine was substituted, and the vessel proceeded to Prince's Bay, New York Harbour, at the rate varying between 280 and 320 revolutions, average about 6 knots, running all the time at cruising trim, that is to say, above the water. She was handled by a new operator, Mr. Cable, who had previously taken charge only in two trips.

The vessel arrived at Prince's Bay at 2.24 p.m., the Otto gas engine, or cruising engine, was replaced by the electric engine for submerged operations. At 2.35 p.m. preparations for submergment commenced. Here it was that the want of experience in the new operator was made manifest, for it was only after several trial dives and alterations in trim were made that the vessel was made ready. Pursuant to orders I was on the 'Holland' at her official trial, November 12. At 3.12 p.m. the vessel dove to 12 feet and was kept submerged at a depth varying between 10 and 11 feet, until 3.23 p.m., when she was brought to the surface. She had then made a run under water, between the times 3.12 and 3.23, of 11 minutes duration, and made the run without difficulty of any sort. At this point Lieutenant Sargent left the vessel, and Commander Emory took his place, the other occupants remaining. After a second set of preliminaries

above described, another dive was commenced at 3.38 p.m., and was maintained uniformly at a depth of 12 feet, until 3.49½ p.m., 11½ minutes, excepting under a misapprehension, thinking that the time was up, at 2.42 the operator brought the vessel to the surface, but immediately descended.

At 3.50 the first short dive was made, at 3.51 another, at 3.52 a third, at 3.52½ a fourth, continuing to 3.54, during which shifted to another air tank, the first one being exhausted, four tanks yet remaining. The fifth and last dive was made at 3.55 p.m. when the vessel ran awash for one minute and then in cruising or above-water trim went alongside a tug, the trial was over, and the Naval Officers left the vessel.

All the operations were witnessed by the Board from a Tug Boat accompanying; and by a numerous party of spectators in a second tug.

The Holland carried flag poles and flags above her surface, thus making her position visible to the Board and spectators and care was taken not to submerge these poles and flags, which could easily have been done. In presence of the enemy these poles and flags would not have been attached, and the vessel would have been completely invisible.

During the entire run the maximum inclination fore and aft was 12 degrees by the head and 3 degrees by the stern.

The consumption of electricity from the storage battery was evidenced by a fall from 124 volts at the start to 118 volts at the finish, 104 volts being limit. Therefore, one-third of the electricity was consumed, and a run three times the length of this one could have been made. In emergency 104 volts could be encroached upon, but is not desirable at ordinary times.

In the living spaces the atmospheric pressure was not exceeded and the air was quite pure, being refreshed by the discharge of air from the steering engines, and from discharging the ballast tanks.

On Sunday, November 13th, according to the order of the Navy Department, I reported before the Board mentioned. After consultation, the Board decided to have another trial of the Holland, and the Board adjourned.

Availing myself of the latitude allowed me, I beg leave to say that the United States Navy is in a peculiar predica-

ment regarding Torpedo Warfare, which I can only make plain by briefly discussing the present state of Torpedo Warfare as follows:

Approaching the subject, we proceed no further than the threshold before we are struck with the intense importance attached to extreme speed as the most indispensable factor in a Torpedo Vessel. So great is the stress laid upon it, that to obtain the least increment, everything else which might be of value to a vessel is ruthlessly sacrificed, until (I think) the 'Reductio ad Absurdum' is reached in plating less than 1/16 inch thick which even a footstep can indent; and in general frailty which has become a proverb.

Nevertheless, it is persistently claimed, that these frail craft have in them power to defeat ironclads and to disperse navies, because (they say) admitting the difficulty of hitting any moving object with any projectile, it follows that the greater the speed the greater the difficulty. Consequently, if a vessel becomes speedy enough she cannot be hit at all, and is, therefore, invincible.

Now, it so happens, that the British Navy, vast as it is, has had no experience of its own in actual Torpedo Warfare.

Considering then, the importance of the British Navy to the British people, it is easy to see how a claim like this has naturally so worked upon the British mind that we perceive them panic-stricken, safeguarding their navies by building torpedo vessels, torpedo-boat catchers, and torpedo cruisers, each edition striving and surpassing the previous ones in the extreme theory described. Now then, also, it so happens that in Naval matters the British lead, and, perforce, other nations follow; therefore (to my mind), is explained how all the world has (as I assert) built up upon panic-stricken theories, methods and appliances for torpedo warfare, upon panic-stricken and mistaken lines.

Consider now the facts in the history of Torpedo Warfare.

(a) We find that no successful torpedo attack has ever been made at extreme high speed.

(b) In all successful attacks, stratagem, concealment, surprise, and similar factors, are the prime elements prevailing.

(c) Extreme high speed has always nullified attempts at stratagem, concealment, etc., either by smoke, 'Bone in the

mouth ' or ' Wave commotion,' any one of which easily betrays the attack to the searchlight.

(d) The attack once discovered is defeated, and if persisted in is certain death to the assailant, and certain destruction to the boat.

For the facts enumerated under (a), (b) and (c), we have familiar proof in ordinary Fleet Exercise.

In this, while in the Harbour, with everything, except dark night, in favor of the defence, we frequently see ordinary Navy Steam Launches successfully evade the searchlight and torpedo the flag-ship by hitting her with a Roman candle, all efforts of the defence to the contrary notwithstanding.

For that fact enumerated under (d); it is to be remembered that at the inauguration of Torpedo Warfare (1861 to 1865), Marine artillery was one thing, but now it is another, quite another thing, and that, furthermore, it is every day in American hands receiving rapid improvement.

Therefore, it is safe to say under present and the future rapid-fire gun practice, our present methods, appliances, and absurdly frail vessels, for Torpedo Warfare, cannot now live, still less can they live in the future.

I venture further to say that if Admiral Sampson had dared he would have sent torpedo vessels into Santiago, and I also assert, as proven by the fact, that they were not so used, that they were not fit, and could have accomplished nothing satisfactory. We are then face to face with the facts, and are forced to the conclusion that our present methods and appliances for torpedo warfare are worse than worthless and ought to be abandoned.

In this dilemma we are forced to look upon other methods and to consider the possibility of submarine warfare and of submarine vessels as weapons.

The facts recorded in this report prove, beyond shadow of doubt, that submarine vessels are a distinct practicability and that, therefore, submarine warfare is capable and worthy of development.

Furthermore (in my judgment), development has already proceeded far enough to warrant the conclusions following:

(a). Whatever a common above-water torpedo vessel is, a submarine torpedo vessel is that, and much more.

(b). Not forgetting the under-water shot received by the Kearsarge; nevertheless, it is safe to say that a submarine vessel is safe from above-water artillery.

(c). A submarine vessel can at any time, day or night, deliver a perfectly concealed attack at a respectable speed.

(d). She can mine and countermine without let or hindrance from anyone.

(e). She can at any time, enter any harbour upon reconnaissance.

(f). The mere fact of her existence and presence would make her adversaries very nervous men.

(g). Until a party can be discovered, submarine warfare will become exceedingly formidable and likely to create as great revolution in naval methods as that wrought by the Monitor.

It is not to be asserted that the 'Holland' is a perfect vessel of her kind, but neither has any vessel yet built approached anywhere near perfection, but the 'Holland' is so good a vessel as to deserve consideration from the Navy Department, and to my mind the policy which drove the Hotchkiss Gun, with other inventions, from native to foreign shores for development should not in the 'Holland' be repeated.

Yours faithfully,
(Signed) JOHN LOWE,
Chief Engineer, U.S.N.

Hon. Secretary of the Navy.

THE TESTIMONY of Admiral Dewey, U.S.N., and Rear-Admiral Philip Hichborn, U.S.N., Chief of the Bureau of Construction and Repair, taken by the House Committee on Naval Affairs on April 23, 1900, while said Committee was considering House Bill 6966, providing for twenty boats of the 'Holland' type.

By favour of the 'Navy & Army Illustrated.

CCXV. AMERICAN SUBMARINES IN CUTCHOQUE BAY, LONG ISLAND, N.Y.

SUBMARINE NAVIGATION

BEFORE THE HOUSE COMMITTEE ON NAVAL AFFAIRS, APRIL 23, 1900.

HEARING UPON THE RESOLUTION FOR THE PURCHASE OF TWENTY SUBMARINE TORPEDO BOATS OF THE 'HOLLAND' TYPE.

Present:—Hon. Alston G. Dayton, Acting Chairman, and Hon. R. B. Hawley, Hon. Henry C. Loudenslager, Hon. Adolph Meyer, Hon. Amos J. Cummings, Hon. William W. Kitchen, Hon. Charles K. Wheeler, Hon. Farish C. Tate, Hon. William D. Vandiver.

The Chairman: We will now proceed to this hearing on the 'Holland' torpedo boat. Gentlemen of the Committee, we have with us Admiral Dewey and Rear-Admiral Hichborn who will be prepared to speak upon this matter, and, inasmuch as the measure was introduced by a member of this Committee (Hon. Amos Cummings) an old and experienced member, I will ask him to take charge of the examination.

Mr. Cummings: I will just say, Mr. Chairman, that this submarine boat is the result of probably twenty-five years' work of actual experiment. The work was begun by Mr. Holland, and for years experiments were made with it in New York Harbour and finally when we deemed that he had secured a practical result and that the boat would do what he claimed it would do, there was provision made in the appropriation bill for the purchase of the vessel provided it fulfilled the requirements. It has been tried repeatedly by a board of naval officers and in the last report they were unanimous in the opinion that it did fulfil the requirements and, believing that the safety of the country would be enhanced by the purchase of such boats, I had the honour of introducing the resolution which is before you providing for the purchase of twenty of these 'Holland' boats. I believe that Admiral Dewey has witnessed the performance of the boat and it would be desirable to have his opinion.

The Chairman: We will be only too glad to have the Admiral's opinion in reference to it.

Statement of Admiral George Dewey.

Admiral Dewey said: Gentlemen, I saw the operation of the boat down off Mount Vernon the other day. Several members of this Committee were there. I think we were all very much impressed with its performance. My aide, Lieutenant Caldwell, was on board. He could tell, if necessary, what was done from the inside. The boat did everything that the owners proposed to do. And I said then, and I have said it since, that if they had had two of those things in Manilla, I never could have held it with the squadron I had. The moral effect—to my mind it is infinitely superior to mines or torpedoes or anything of the kind. With those craft moving under water it would wear people out. With two of these in Galveston, all the navies of the world could not blockade that place. I agree with the resolution of Mr. Cummings. I think it would be money well spent. I think it would tend to keep peace. That is what we want a navy for. We want peace.

Mr. Cummings: Admiral, I drew up some questions this morning, which I would like to ask you in connection with this matter. What is your opinion as to the performance of the 'Holland' of the various evolutions of the trial exhibitions made off Mount Vernon on the 14th of March, at which you were present?

Admiral Dewey: I think they were wonderfully successful.

Mr. Cummings: What do you think would be the value of similar submarine boats as harbour and coast protectors against hostile fleets in time of war when manned by crews skilled in their management and use?

Admiral Dewey: They would be most valuable.

Mr. Cummings: Would or would not a number of such boats, efficiently manned by expert officers and crews, so protect our coast and the entrances to our harbours in time of war as to practically free our battleships and cruisers from harbour-defence work for offensive work at sea and on hostile shores?

Admiral Dewey: Certainly.

Mr. Cummings: Would not the moral effect of the presence

of several of these submarine boats ready for instant service in each of our principal seaports greatly conduce to the security of those ports, and be a potent deterrent to an enemy's fleet?

Admiral Dewey: In my opinion they would be of the greatest use.

Mr. Cummings: Would it not be wise to have a number of these boats, as now constructed, in use in time of peace for the training of the officers who would have to command and operate them in time of war?

Admiral Dewey: I think so most assuredly.

Mr. Cummings: Would not the possession of the improved type of 'Holland' boat, designed as number seven, ready for action in each of our seaports prove a powerful aid in assuring the safety of our harbours from the attacks of an enemy?

Admiral Dewey: Was that number seven that we saw? That is the only one I have seen and the only one I am familiar with at all. I have read of the doings of all of them.

Mr. Cummings: Would it not be of the highest degree of importance in time of threatened war or of complication with a foreign government to have complete harbour defence afloat that can be available for instant action and at small expense?

Admiral Dewey: I don't think I quite understand.

(Mr. Cummings repeated the question).

Admiral Dewey: Most certainly.

Mr. Cummings: The highest degree of importance in time of threatened war to have these boats available for instant action?

Admiral Dewey: Yes, of course.

Mr. Cummings: If the submarine boats constructed and stored at each harbour can be made ready for action within a few days when required, would you not deem them to be most desirable acquisitions by the Government?

Admiral Dewey: I would.

Mr. Cummings: With your knowledge of the extensive fortifications of the British Government at the ports of Esquimault and Vancouver, on the Pacific, of Halifax, Nova Scotia, of Bermuda and of Nassau and of the short distances from those several ports to the coasts of the United States,

what ports on our coasts do you consider as requiring to be at all times thoroughly protected from attack by water?

Admiral Dewey: New York of course. The entrances to the Delaware and Chesapeake Bays.

A Member: Hampton Roads?

Admiral Dewey: Yes; that would be the entrance to Chesapeake Bay. Hampton Roads, that means the entrance. That is where Chesapeake Bay should be defended, at the Capes of Virginia—Capes Charles and Henry. All of our ports should be equipped with them. New Orleans, of course. Galveston, that is one of our great ports. San Francisco, of course, and the entrance to Puget Sound. In order to answer that really intelligently, I should have to give it some thought.

Mr. Hawley: The idea of this question is to determine the number of ports?

Mr. Cummings: Yes.

Mr. Hawley: Wilmington and Savannah?

Admiral Dewey: Yes; all those places.

Mr. Wheeler: Key West?

Admiral Dewey: Of course, if an enemy would get possession of Pensacola Bay it would be its base. They would use that for a base. Of course, Long Island Sound—the east end of Long Island Sound. I should think the number that you contemplate, twenty, would be good to start with, because they could be moved. They can be moved from point to point.

Mr. Cummings: They can be moved by the inland waters, if necessary.

Admiral Dewey: Yes, by the inland waters.

Mr. Loudenslager: I was going to suggest, Mr. Cummings, that possibly the Admiral would like to answer that after a little more reflection and naming the ports in importance.

Mr. Cummings: It seems the Admiral is a very busy man.

Admiral Dewey: Just now I am.

Mr. Cummings: It seems to me that, with the information we have already obtained from the Admiral that twenty boats is not too many to start with. Some of these boats ought to be placed on the Pacific and the others on the Atlantic.

Mr. Wheeler: What are they going to cost?

Mr. Cummings: Not as much as a battleship.

Admiral Dewey: The whole twenty?

Mr. Tate: Do you know about how much apiece?

Mr. Frost: One hundred and seventy thousand.

The Chairman: I suggest, gentlemen, that we inquire into that matter before the hearing is over.

Mr. Cummings: Considering the moderate cost of the improved 'Holland' Torpedo Boat, with its increased speed, its ease of handling, and its torpedo efficiency, and the fact that only five men are required to man and operate each boat, would you not say that the interests of the Government, through the providing of such defences for our great seaports, will be advanced by the prompt construction of such boats for that service?

Admiral Dewey: Certainly I would.

Mr. Cummings: If twenty of the improved 'Holland' Torpedo Boats can be purchased for the cost of one battleship and constructed in one-fourth of the time, would you not deem it wise to make immediate provision for the purchase and distribution of that number of said boats along our coasts?

Admiral Dewey: I would.

Mr. Cummings: Would not these improved 'Holland' Submarine Boats prove a most efficient protection for the entrances of the contemplated inter-oceanic canal?

Admiral Dewey: There is nothing better.

Mr. Cummings: Mention any other points that may occur to you as the result of your observation of the performances of this boat.

Admiral Dewey: Well, I think I have covered that in what I have said; that from what I saw my own belief is that I could not, with my squadron, fifteen ships—if the enemy had had two of those boats with determined Americans on board—have held that bay. It would have worn us out. We would have had to be under way and never known when the blow was going to strike. It would have worn us out. The human frame would not have stood it. I think so now, as I said before. Of course, submarine means with torpedoes. Torpedo boats, surface boats; I don't give much for those.

Mr. Loudenslager: What chances, Admiral, would you have had for destroying these boats?

Admiral Dewey: That would have been the trouble. I hadn't a vessel that could have got into Pasig River, and they would have come out at night and we would not have seen them. They would have had that opportunity and taken dark nights, and we would not have seen them until they were close to us, and my experience is that you fire very badly in those conditions; I mean aim badly. And the chances are not very good. She only came to the surface for a moment.

Mr. Loudenslager: How long?

Admiral Dewey: Only ten seconds. You could not train your guns on them. I think, in the interests of peace, and that is what we all want, it would be money well spent.

Mr. Meyer: I would take it that these questions that have been asked and answered, and the main answers especially refer, in the main, to the moral effect the presence of these boats would have in a harbour. What do you think of their material efficiency in discharging torpedoes and striking the enemy,—striking an enemy's vessel with effect?

Admiral Dewey: I think Mr. Caldwell could answer that better. He was on board. The thing that I saw,—that we saw, down at Mount Vernon,—apparently did not aim at anything, that part I am not prepared to say. I assume, though, that they would not build a vessel of the kind. Have they good means of aiming?

Lieutenant Caldwell: They aim the vessel. They fire the torpedo from the bow.

Admiral Dewey: The vessel is——

Lieutenant Caldwell: Is the train.

Mr. Meyer: Could you hit anything?

Lieutenant Caldwell: Yes, sir, the inspection board reported on that. They fired a torpedo between two flags, aiming very successfully.

Mr. Hawley: What was the distance between the flags?

Lieutenant Caldwell: I don't remember, sir, the report is on file. The torpedo, on the run at Mount Vernon, was fired at an imaginary target.

Mr. Meyer: I would suggest, after our colleagues have

asked such questions as they may desire, that we hear from the Lieutenant as to his experience.

Mr. Kitchen: I will ask the Admiral this question: Admiral, you know the House has passed the Naval Bill providing for six cruisers—that you already know about—and also two battleships?

Admiral Dewey: Yes.

Mr. Kitchen: Would you prefer to have only one of the battleships and these twenty submarine torpedo boats, than have the two battleships? I mean by that, this: if you had been going to draw the Bill and could have had only the two battleships without these boats and only one battleship with these boats———

The Chairman: I don't think that is a fair question.

Admiral Dewey: I think you ought to have both.

Mr. Kitchen: The Admiral might prefer fifty battleships, but I was putting a hypothetical question as to his preference when he could not have both.

Mr. Cummings: If the House could authorise fifty battleships and at the same time refuse to provide means for their construction, don't you think it would be better to have twenty torpedo boats that are not fitted with armour plate? I do not insist on the Admiral answering if he does not wish to.

A Member: He said he would have both.

Mr. Kitchen: I don't think that is any answer, because every man here would like to see our navy have fifty battleships and have both.

The Chairman: Inasmuch as this is a public hearing it is not a question of policy so much as a question of fact in regard to this invention.

Mr. Vandiver: I would like to ask the Admiral one or two questions for information. In the first place, are other governments manufacturing any of these boats?

Admiral Dewey: I understand the French Government—do not understand that they are 'Holland' boats especially but they are——

Mr. Vandiver: Submarine torpedo boats?

Admiral Dewey: Submarine, too, aren't they, Admiral?

Admiral Hichborn: Yes.

Mr. Vandiver: I presume the Admiral is acquainted with

the different types of these submarine torpedo boats. I would like to ask his opinion. I don't want to involve him in invidious comparisons at all, but as we are here for that purpose I would like to ask his opinion about this as compared with others that are manufactured by other governments.

Admiral Dewey: I have seen only this one. All I have heard of the others is what I have read in the papers. This I have seen. Nothing could have been more perfect than its operation off Mount Vernon the other day. It did exactly what its officers proposed to do.

Mr. Vandiver: Now I was present at the trials the Admiral refers to, and I think, agreeing with all those who were present,—and we were all very much delighted with the experiment—entirely satisfied and all that—and so now it becomes a practical question as to what we shall do, and I want to say this that has occurred to me: I don't know whether it is entirely practicable or not but would like to ask the Admiral his idea about it, if, as we are disposed to think, I think all of us, that this is the best type of submarine torpedo boat we are acquainted with, at any rate, would it not be well, if we undertook to manufacture any of them at all, to have entire control of this pattern or patent, if it is such, so that the Government of the United States could avail itself exclusively of the use of this most perfect torpedo boat that is known, assuming that it is?

Admiral Dewey: I think that is a matter for the Committee to decide. I will answer that by saying that I am not prepared to give an opinion on that subject. I have not looked into that matter at all.

Mr. Vandiver: That question has arisen in my mind. I don't know what the legal status of the matter is, but I have been very favourably impressed with these experiments as we all have.

Admiral Dewey: So was I. I was with you at the time.

Mr. Vandiver: Assuming that it is a very useful thing and going to be of great value, it has occurred to me that the Government ought to control the whole thing.

The Chairman: Would not that be a question of policy for us to determine later?

Mr. Vandiver: Yes.

The Chairman: In other words I don't think this Committee in a public hearing ought to express its opinion about these matters, but have a private hearing.

Mr. Vandiver: I asked the Admiral for a comparison of the type for the purpose of getting at that later.

Mr. Wheeler: It is a matter of detail. Admiral, I don't know whether you are prepared to answer it, but I want to ask would it be possible for a battleship to carry one of these torpedo boats along with it?

Admiral Dewey: What do you think (to Lieutenant Caldwell).

Lieutenant Caldwell: It might be practicable to carry it, but it would not be desirable, it would take up so much room and weight.

Admiral Dewey: What is about the weight?

Lieutenant Caldwell: One hundred and three tons on the surface.

Admiral Dewey: That is a pretty heavy weight. It would affect the stability. You would have to carry it on top.

Mr. Wheeler: Could any sea-going ship, a big cruiser, something of that sort, carry it, do you think?

Admiral Dewey: Yes; you could have the vessels fitted to carry those boats. Take some of these big steamers; they could carry half a dozen of them, hoist them right on board, and carry them, for instance, from point to point along the coast where it was threatened.

The Chairman: Taking into consideration the difficulties at sea, do you believe that the use of this torpedo boat could be extended to the fleet formation on the high seas?

Admiral Dewey: I should think not.

The Chairman: The danger is of its being lost?

Admiral Dewey: Yes. I should think so.

The Chairman: In your judgment, it would be confined to harbour and coast defence?

Admiral Dewey: Absolutely, yes.

Mr. Loudenslager: I would like to ask a question in regard to cruisers carrying one of these torpedo boats along with them. What means would they employ to load this torpedo boat on deck?

Admiral Dewey: Derricks. They would have to have heavy derricks.

Mr. Loudenslager: How could they get it off the deck at sea?

Admiral Dewey: We would work it out. The Chief Constructor would work it out. You might have the vessel so constructed that the side of the ship would come out near the water's edge and then launch them.

Mr. Loudenslager: What is the length of one of these vessels?

Admiral Dewey (to Lieutenant Caldwell): What is the length?

Lieutenant Caldwell: Sixty-three feet. The 'Holland' is fifty-four.

Mr. Loudenslager: Would not such an arrangement as you suggest weaken the efficiency of a cruiser?

Admiral Dewey: Very much. I would have transport steamers. Nowadays a fleet will have to carry colliers and hospital ships and ammunition ships. It would have to have one that could carry it. I don't think this would be used on the high seas much. I should not think so.

Mr. Loudenslager: That was the point.

Admiral Dewey: Yes; I should not think they would be used on the high seas.

Statement of Rear-Admiral Philip Hichborn.

The Chairman: Gentlemen, I take the pleasure in introducing to you a gentleman very well known as head of the Bureau of Construction and Repair, Rear-Admiral Hichborn. For the same reason I will ask Mr. Cummings, the author of the Bill and member of the Committee, to conduct the examination.

Mr. Cummings: Admiral, I would like to ask you first your opinion regarding the desirability of constructing submarine boats for use in the navy.

Admiral Hichborn: I think it is important that we should construct them, and I say that after careful consideration of the subject having had two naval constructors who have been

connected with the building and the trial of these boats, extending over a period of two or three years, in which both of those constructors, Constructor Varney and Constructor Capps, gave me as their personal opinion that they considered that these boats were very useful for the Service.

Mr. Cummings: You say the French Government has been constructing some of those boats. Do you know how many?

Admiral Hichborn: They have carried on this building of submarine boats for ten or fifteen years. I cannot say how many they are building at the present time. There was a proposition by the French Government to build about a dozen about a year ago.

Mr. Wheeler: The same kind of boat?

Mr. Cummings: Submarine.

Admiral Hichborn: Boats of their own construction. The boat they had under trial did not prove as satisfactory as was expected, and they called a halt.

Mr. Cummings: Have the English made any experiments in submarine boats?

Admiral Hichborn: The English have never taken any part in submarine warfare.

Mr. Cummings: Germany or Russia?

Admiral Hichborn: The Germans in one instance, I believe.

Mr. Cummings: What was the result?

Admiral Hichborn: It was not satisfactory, but it was several years ago.

Mr. Cummings: The Russians or Italians?

Admiral Hichborn: The Russians built one boat, but did not continue it, and the Italians built one. That was several years ago; within the last eight or ten years I don't think they have indulged in it at all.

Mr. Cummings: You say these constructors have been experimenting with these boats for three years?

Admiral Hichborn: They have been connected with the construction of this 'Holland' and this 'Plunger.' Constructor Capps has been down in the 'Holland.'

Mr. Cummings: Their reports are favourable?

Admiral Hichborn: Their reports are favourable, yes.

Mr. Cummings: Do you know anything about the 'Holland' boat? Have you been in it?

Admiral Hichborn: I have been in her. I am familiar with the plans and the building of the 'Plunger' at Baltimore has been under my direction.

Mr. Cummings: Have you ever witnessed any of the experiments of the boat?

Admiral Hichborn: I am very sorry to say that I missed these experiments down here. Business prevented me going at the time. I expected to go. I have not had an opportunity. Still, I have kept in touch very closely with the trials and with the people who did witness the trials.

Mr. Cummings: Do your constructors agree that all the difficulties that were experienced at the beginning of the construction of the 'Holland' boat have been overcome and that she is now a perfect type of a submarine boat?

Admiral Hichborn: I do not know that they say that she is perfect. It is pretty extensive to say that any piece of mechanism is perfect. They say she fulfils all the requirements laid down by the Government up to the present time, which are quite extensive.

Mr. Cummings: In your opinion then, it would be very desirable to have twenty boats constructed?

Admiral Hichborn: I think twenty would be a desirable number. It is not many boats when you consider the length of the coast and number of harbours to be defended. The Admiral didn't get down as far as Portland, nor to Provincetown. You all recollect in this last war that the people from Maine to Massachusetts, through their Senators and Representatives, were besieging the Navy Department to have the old monitors go down there and help take care of them so the people could sleep nights. The old monitors had been condemned more than thirty years ago; we dug them out and took them down there and everybody seemed to be happy after that. That goes to show how these things operate in war.

Mr. Hawley: As to the moral effect?

Admiral Hichborn: Moral effect all round—to the inhabitants as well as to the enemy.

Mr. Loudenslager: I see by the report of the Admiralty that France has twelve submarine boats.

Admiral Hichborn: Twelve? I had not followed it up so closely. I know of seven.

Mr. Cummings: From what you have observed, is there a reasonable certainty that they would be able to destroy a battleship blockading a harbour with torpedoes?

Admiral Hichborn: I do not see anything to prevent it if skilfully managed—if they should go out and meet the ships.

Mr. Cummings: With a crew completely organised and controlled there would be no trouble at all in disposing of the battleships?

Admiral Hichborn: If they should ever send off one of those torpedoes we have not a battleship that would stand it if they should succeed in hitting her.

Mr. Cummings: Do the reports of the constructors indicate that they could hit her with the torpedoes?

Admiral Hichborn: Well, the subject was generally treated as to the efficiency of the boat. I don't know that that was touched on particularly.

Mr. Cummings: I understand they carry three torpedoes?

Admiral Hichborn: And a spare one.

Mr. Cummings: And provisions for twenty-four hours on the boat?

Admiral Hichborn: Yes; they can carry a little more if they want to and occasion required.

Mr. Kitchen: This card says it carries five torpedoes—five eighteen-inch—White-head torpedoes.

Mr. Cummings: I have been reading the reports of the board. One of the reports speaks of her carrying three. In your opinion is the price asked for the construction of these boats reasonable?

Admiral Hichborn: I consider it reasonable, quite so when one goes down to see the complicated mechanism and time and labour necessary to work it out; I think the price is reasonable.

Mr. Cummings: Is the machinery of the vessel any more liable to get out of order than the machinery of a war vessel?

Admiral Hichborn: No; I should not think it was.

Mr. Cummings: Would it cost any more to keep these boats in order than it would cost to keep torpedo boats?

Admiral Hichborn: It would not cost as much. They are not so delicate as the torpedo boat.

Mr. Cummings: They are not so delicate as the torpedo boat?

Admiral Hichborn: No, sir.

Mr. Cummings: Then they serve every purpose that the torpedo boat serves with the addition of being under water and out of sight?

Admiral Hichborn: They serve every purpose and the additional purpose because a surface torpedo boat, if she is ever discovered, cannot get out of the way. It would be wiped right out of existence. Not so with this kind of boat. It is a small target and it would be almost impossible to hit her.

Mr. Cummings: Then the construction of these boats, twenty of them or fifty of them, would do away with the necessity for torpedo boats?

Admiral Hichborn: I think you would need both.

Mr. Cummings: You frequently use a torpedo boat as a dispatch boat because of her great speed?

The Chairman: Mr. Cummings, let me suggest, would not the field of the torpedo boat then be defined more particularly as an adjunct to the fleet formation at sea and these, of course, to harbour defence?

Admiral Hichborn: I haven't much faith in the torpedo boat operating with a fleet at sea. The fictitious speed disappears at once when any sea is on. I say, on general principles, that all weapons of that kind are useful in warfare, and you would not want to give up the torpedo boat for the submarine boat. You would want them both. They would each play their part, for the torpedo boat, with her high speed, could, if nothing more, go out and attract the attention of the enemy and worry him while the submarine boat carried out the other part of it and made the actual attack.

Mr. Cummings: How much per cent. would they add to the efficiency of the harbour defences of a city like New York?

A Member: Inestimable.

Admiral Hichborn: I do not know that I could express that percentage. I know that we would all feel very com-

fortable if we had two of these boats round New York Harbour, and if there was a stir about a foreign fleet going in there or around there, it would be a very comfortable feeling and the price would be a mere bagatelle.

Mr. Cummings: In comparison with the increased resistance to the enemy?

Admiral Hichborn: Certainly I would like to add a little to what I have already said, as it does appear to come out, that my views on these submarine boats would be after we got them, that they would be a very useful weapon for the naval militia of the different States to drill with, and when our officers and men all went away on fighting ships we would have these submarine boats manned by the naval militia of the different States, for their operation is so mechanical that we could very readily get skilled and competent men to manage them.

Mr. Hawley: How many men man these boats?

Admiral Hichborn: I think it is reduced down to five or six.

A Member: You would not want any more in actual attack but would need more in reserve? How many would you say should be ready to take charge of this boat and go out with her?

Admiral Hichborn: There should be different ones—all skilled men that have courage and skilled directly in this particular branch.

Mr. Hawley: A number of crews for each boat?

Admiral Hichborn: A number of crews for each boat.

Mr. Loudenslager: Have you ever heard of experiments made by the 'Holland' Company demonstrating the ability to——

Admiral Hichborn: I have talked with the constructor detailed on the boat.

Mr. Loudenslager: What was your opinion about these results?

Admiral Hichborn: I considered they were very satisfactory.

Mr. Loudenslager: Can you state what they were verbally?

Admiral Hichborn: The Department laid down certain requirements. I was a member of the Board that laid down

these requirements. They were principally prepared by the Chief of Ordnance. That the boat should be able to go down under water and run a certain length of time; that she should be able to fire a torpedo in a straight line I think between two points.

Mr. Loudenslager: Do you know the distance between those two points?

The Chairman: Those papers are not private are they?

Admiral Hichborn: Not at all.

The Chairman: Can we ask you on behalf of the Committee to furnish those reports?

Mr. Cummings: I have them here.

Mr. Loudenslager: If we have those I will not continue my inquiry.

The Chairman: Without objection by the Committee, Mr. Cummings, will you furnish those and have them appear in the report of the hearing?

Mr. Cummings: Yes.

Mr. Loudenslager: You spoke of the protection two or three of these boats would afford to a port like the city of New York in defending it against the approach of an offensive fleet. Supposing that fleet were entering the harbour in the daylight in the morning, would these be very efficient at that time?

Admiral Hichborn: I consider they would.

Mr. Loudenslager: Is it possible to destroy them before they do effective work?

Admiral Hichborn: The target would be very small and difficult for an enemy to hit.

Mr. Loudenslager: Well, with a fleet of eighteen or twenty vessels firing at them, all of them, what likelihood would there be of a fleet of that kind destroying them before they did very much effective work, in your judgment?

Admiral Hichborn: Of course, it depends a great deal upon the skill of the gunners and all that. I think you could answer that question as well as I could.

Mr. Loudenslager: I do not think I could. Your knowledge——

Mr. Hawley: Will you tell the Committee how long it would take to construct these boats?

Admiral Hichborn (replying to the previous question): That is a question a little out of my line of business—the fighting part of the business—I do not think I have——

Mr. Hawley: I will reserve that for the Lieutenant.

Admiral Hichborn: I have already branched out a little from my regular line of business. My business is more particularly to build vessels, and I am always willing to give an opinion on the construction of a vessel. Aside from that I am not trained for warfare.

Mr. Hawley: How long would it require to construct one of those boats, working under stress ?

Admiral Hichborn: I suppose six months, unless there were great necessity for them.

Mr. Hawley: I say working under stress, working with all speed.

Admiral Hichborn: I suppose you could build her and try her in about six months. I would not advocate building them in a hurry.

Mr. Hawley: How long would it require to build them in the most effective way ?

Admiral Hichborn: If I were building them I would extend the building over a period of three years unless occasion required haste.

Mr. Hawley: Would you have them all under construction during that period ?

Admiral Hichborn: I would have them all under construction but have the completion at different periods so that the first boat would be finished with an interval of time coming in before the completion of the others, because no vessel was ever built yet that there was not something that in a second one could be improved upon, and unless it were a question of necessity I should prefer to see them carried on in that way; to build the first or second and the others then to come on as rapidly as would be desired.

Mr. Loudenslager: In that connection, which do you think would be more desirable to do, contract for twenty at this time or for five this year, and then six months after their completion and trial for five more, and so on until you got a sufficient number ?

The Chairman: Would not that be answered by your first

statement that you would extend the time for their completion at different times, and would not a contract for twenty be likely to be gotten at a less price than five?

Admiral Hichborn: I think you would get better results.

Mr. Loudenslager: Would not the changes in construction you speak of the likelihood of there being, naturally increase the cost of the next that were built by virtue of the change in the plans and in the construction?

Admiral Hichborn: I do not anticipate the changes would be great, but, as I said, we never built a ship and duplicated her but what we have had some slight changes.

Mr. Loudenslager: Is it not the natural result that when the Department changes the plans of a ship that it costs much more in proportion than when you design them in the first place?

Admiral Hichborn: It is not from the design of the vessel so much as the change of ordnance and the change of turrets and change of power. I am only explaining the changes that have been made in our battleships and cruisers. There might be some change that would be found more desirable to put into a second vessel.

Mr. Cummings: Admiral, has the Navy Department purchased this vessel, the 'Holland'?

Admiral Hichborn: I understand it has, but nothing has passed through my office that will show it.

Mr. Cummings: It will be turned over to your Bureau if she is purchased.

Admiral Hichborn: Yes, sir.

Mr. Meyer: With reference to the interior construction of this ship, does it afford ample safety for the men who are in it. Is the construction so secure that danger of the air being cut off or disarranged, by means of which the men could not exist in the interior—are those arrangements effective?

Admiral Hichborn: I consider them safe because the vessel goes to the surface in case of any accident. She has a surplus of buoyancy and she comes to the surface if there is anything wrong with the machinery. You can make it greater if you choose.

Mr. Meyer: I think last summer, in the harbour, that the

crew came very near being asphyxiated and the boat came to the surface by some experiment near Jersey City?

Admiral Hichborn: I think that was a leak in a tank or something—in some gas that is generated. Of course, that is a matter that can be always more skilfully looked after, that Jersey City matter, by looking after matters of that kind. In looking up the history of submarine boats in the early days, more than one hundred years ago, I find there has never been a case where a man lost his life by a submarine boat. Men have been lost in boats called submarine boats, but they have been operated on the surface; but never been lost by the sinking of the submarine boat and not coming up.

Mr. Tate: What are the types of submarine boats that your Department has investigated other than the 'Holland'?

Admiral Hichborn: There have been in the last eight or nine years different kinds of boats submitted. There was a gentleman up on the Lakes who submitted a submarine boat. A committee was appointed and went up there to see her operated. I forget the name of the inventor. But she was not very successful.

Mr. Tate: Has your Department investigated the type of submarine torpedo boats turned out to-day by the French Government?

Admiral Hichborn: We have an attaché there who follows up that matter pretty carefully all the time. He sends reports to the Department which are considered confidential, but the Chiefs of Bureaus are allowed to read them. So I feel that we are pretty well posted in regard to the French boats.

Mr. Tate: You get your information in that way?

Admiral Hichborn: Yes; and from other public descriptions.

Mr. Tate: These experts in your Department have acted upon the information you have received in that way in relation to that boat?

Admiral Hichborn: Yes.

Mr. Tate: Do you regard this matter of submarine boats as largely a matter of experiment?

Admiral Hichborn: No, sir.

Mr. Tate: You do not?

Admiral Hichborn: No, sir.

Mr. Tate: Then why not build all these boats at once?

Admiral Hichborn: I might explain that it has passed the experimental stage.

Mr. Tate: You think it has not passed the stage of improvement?

Admiral Hichborn: I think there might be some improvements.

Mr. Hawley: Do you think the battleships have passed the stage of improvement?

Admiral Hichborn: No, sir. I do not think any piece of mechanism has passed that stage.

Mr. Tate: You think the torpedo boat question has passed the experimental stage?

Admiral Hichborn: Yes, sir, so far as recommending it for a weapon of warfare in our navy.

Mr. Tate: Would you think it advisable now to provide for building three of those boats at a time, or twenty at a time?

Admiral Hichborn: I think that question was up before. I stated I would be in favour of building twenty, that is, to understand that we were to build twenty.

Mr. Tate: I understand that you were for providing for building two or three at a time and later on building the others?

Admiral Hichborn: I would not have more than a month or six weeks between the completion of each one. You can take any case of shipbuilding. If you have one ship in advance of the other and launch that and get her completed first you will save time and money on the second boat by having her in the lead all the time. She is a sort of furrow that leads, leaving the others simply to follow it.

Mr. Tate: Your idea is to provide for twenty and make the contract so as to avail ourselves of the improvements in the boat?

Admiral Hichborn: That would be a matter of contract that would probably enter into the policy of the Department in doing that.

Mr. Cummings: Our coast certainly needs protection as soon as possible and you would provide for the twenty boats,

as I understand, with a month or six weeks intervening between the completion of each boat?

Admiral Hichborn: Yes, sir. I say that merely as matter of precaution so as to get the most efficient boat. It would be like this: if you had appropriated in the Bill and had the contract all made to finish them all at one time and rushed ahead and finished them you would copy any error twenty times, whereas a difference of a month might correct that error.

Mr. Kitchen: The first inspection I believe, showed the boat could not be steered well— that it was unsteady. That was the first report of the Inspection Board, wasn't it, that while it would pursue a straight course, if you tried to turn it one way or the other it was unsteady or unsatisfactory?

Admiral Hichborn: I do not call that to mind, particularly the objectionable part. I think that went on at the time when the war was on.

Mr. Kitchen: I read that from the report of the Inspection Board and Survey of November 12, 1898.

Admiral Hichborn: Possibly that might have happened.

Mr. Kitchen: It says (reading from the report):—III. Ability to run under water at depths from 10 to 35 feet at 6 knots, the boat holding a steady course both in the vertical and horizontal planes during said runs, which are to be each not less than ten minutes in duration, not established. Steering was very erratic and boat unable to maintain position under water for more than a few minutes at a time. We believe, however, that this was owing to inexperience of crew. IV. Ability to turn both to starboard and port with reasonable quickness and certainty, steering gear working well, etc., the mechanism for controlling the diving apparatus to be equally efficient and satisfactory. The boat turns quickly, but the steering and diving gear did not work satisfactorily, owing, we believe, to the inexperience of the crew.

I understand there was an inspection after that?

Admiral Hichborn: I think one or two.

Mr. Kitchen: Do you know what the result of the inspection afterwards of the condition in this respect was?

Admiral Hichborn: It gave satisfaction. At the last

inspection all those questions that you have mentioned were never doubtful things.

Mr. Kitchen: They have been perfected so that there is no trouble in guiding the boat and holding a set course?

Admiral Hichborn: None whatever. I think if you will read the report you will see that.

Mr. Cummings: The Board was unanimous in the opinion that she fulfilled all the requirements?

Admiral Hichborn: Admiral Rogers was at the head of that Board. I talked with the constructor here because he came around the office to have a conversation in regard to her after the trial was over.

Mr. Wheeler: I will ask if it is the purpose of the Government to keep the manufacture of these boats secret—not known to other countries?

Admiral Hichborn: I presume it would be of course.

Mr. Wheeler: It is not the purpose of the Government to permit contractors to work on these boats. The Government will take charge of it?

Admiral Hichborn: The contractors would have to work on them, but they would be under penalty and we could have our superintendent and guards to prevent people making notes or sketches, and even going aboard of her.

Mr. Wheeler: I noticed a few moments ago, I think I remember your remarking, that if these boats were constructed it would be advisable to allow the naval militia to drill with them?

Admiral Hichborn: Yes.

Mr. Wheeler: Would not that be rather an unsafe thing to do, if it is proposed to keep the secret as the property of the Government to allow irresponsible militia to go aboard of her and to allow others to go aboard.

Admiral Hichborn: If you thought it of sufficient importance you could have our naval officers detailed for that purpose. I do not think there would be any danger if the naval militia is under rules and regulations.

Mr. Cummings: That would be entirely within the scope of the Navy Department?

Admiral Hichborn: That would depend on the rules that they adopt.

Mr. Cummings: The Government has already bought the exclusive right to make it?

Admiral Hichborn: I do not know, sir. I do not know what the situation is in regard to that. They would have to go into some arrangement with this concern. Probably this concern would contract with the Government to furnish so many boats at such price and the Government to be relieved from all royalties.

Mr. Cummings: I suppose that the Government would have the exclusive right to manufacture these boats and own them if we proposed to manufacture them?

Mr. Vandiver: As I understood, the Admiral a moment ago expressed the opinion that the submarine torpedo boat has passed the experimental stage. I would like to ask further in that connection if it is in practical use in the Navy in other countries, or did he refer only to this?

Admiral Hichborn: I referred to the 'Holland.' I do not think they have any comparison with the 'Holland' in any other navy. They have not reached this degree of perfection.

Mr. Vandiver: As I understand, they have some submarine boats, haven't they?

Admiral Hichborn: The French Government is the principal one that has submarine boats.

Mr. Vandiver: Haven't the English a similar boat?

Admiral Hichborn: No, sir.

Mr. Vandiver: In what respect, speaking only in a general way, do they differ, do you think, from this type?

Admiral Hichborn: The French Government's?

Mr. Vandiver: Yes, sir.

Admiral Hichborn: They are not so manageable. They cannot sink them, and they cannot direct them as well as our boats.

Mr. Vandiver: This is an improvement, then, in the process of directing the boat?

Admiral Hichborn: Yes, sir. The 'Holland' to-day is an improvement on anything that has ever been built in the history of the world.

Mr. Vandiver: I think we were all impressed with it when we saw its operations; so far as our information goes about

others that will enable us to make comparison. In view of that I asked the question awhile ago which seems to me to be of some importance also in connection with the similar question Mr. Wheeler asked. Do not you think it would be advisable, in case we do construct any of these boats, to keep that advantage of this improved method of directing them for the use of ourselves instead of allowing it to become the property of the world generally?

Admiral Hichborn: I do not think it ought to be the property of the world under any circumstances. It is the skill and energy of American brains that have produced it, and you will find, they always go to the front in case of necessity.

The Chairman: The Committee agrees with that sentiment.

Mr. Tate: Especially is that true of American men.

Statement of Lieutenant Harry H. Caldwell.

The Chairman: I take pleasure in introducing to you Lieutenant Caldwell who was on the 'Holland' in her trip down the river.

Mr. Cummings: I would like to have you, Lieutenant, give a detailed statement of your trial trip down off Mount Vernon.

Lieutenant Caldwell: I have made two trips in her. I made one a week ago Saturday—made a second trip—and can tell you more about that one than about the first one. The boat sank prefectly and drove perfectly.

Mr. Cummings: Let us know how you came to go there first—by whose orders?

Lieutenant Caldwell: I went there entirely on my own account, not officially in any way. I went simply because I was interested in the boat and wanted to see how she worked.

Mr. Cummings: You mean you were interested in your professional work?

Lieutenant Caldwell: That is all. Being on duty with Admiral Dewey, I got his permission; that was all.

Mr. Cummings: Now you can go on and state your experience.

Lieutenant Caldwell: This first time we were towed by

a tug and began preparations and made a preliminary balancing test before the Committee came down on the yacht.

Mr. Cummings: What do you mean by balancing test?

Lieutenant Caldwell: That is trimming the boat by pumping water in the forward and aft tanks so that the boat would remain approximately on an even keel. This is done by letting water into the fore and aft tanks gradually and it is simply a case of balancing. I did not know what was going on at the time of the first one but understood it at the second one, and think I could do that part of it. Then we came up to the surface and waited until your Committee came down on a yacht, and then we carried out the programme as you saw. Everything inside is worked by the six men and the captain and worked very smoothly. There was no hitch in any way. The captain steered the boat; that is, in the horizontal plane, and a second man controlled the diving rudder on the opposite side to steering wheel. He has to be a very skilful man, the second man who works the diving rudder, because it is a very delicate adjustment, a very delicate piece of machinery. There is no difficulty about it at all, but it needs training, and I would say that all of the stations in the boat require skilled men with considerable training. The air supply was always good. There was no difficulty about that. The torpedo was discharged at the exact moment the captain gave the order. As far as I can understand it ran very well, but it was not discharged at a target, so that it is hard to say whether it would have struck a ship or not. I cannot say that. There was no difficulty whatever about firing it.

Mr. Cummings: In case you fired a torpedo at a ship would the boat come to the top of the water and take an observation?

Lieutenant Caldwell: Oh, yes; it would be absolutely necessary to have her turret out of the water at the time of firing, because you cannot get your direction otherwise.

Mr. Meyer: She would have to rise, as she did the time she fired that torpedo, and remain for 12 seconds?

Mr. Cummings: Could there be a way of firing the torpedo under water?

Lieutenant Caldwell: Yes, sir. There would be no trouble about that, but you must have a sight at the time of firing and to do that must expose your turret.

Mr. Meyer: Is that the only portion of the vessel that was exposed?

Lieutenant Caldwell: That is all that was exposed; just that little round part on top.

The Chairman: Is that perfectly water-tight down there?

Lieutenant Caldwell: Oh, perfectly. Perfectly water-tight. There is no difficulty about that.

The Chairman: Clean and agreeable?

Lieutenant Caldwell: Clean and very roomy, considering the amount of machinery there is in it.

Mr. Cummings: Air perfect?

Lieutenant Caldwell: The air was perfect.

Mr. Vandiver: What is the method of getting rid of the air after breathing?

Lieutenant Caldwell: It is blown out by a fan.

Mr. Vandiver: That, of course, would be when it comes to the surface, I suppose?

Lieutenant Caldwell: Yes; but they can blow it out under water. To do that they would, of course, admit air from the tanks. They have air compressed up to 2,000 pounds pressure in the tanks, and allow that to come out at about the normal pressure of the air in such quantities as they see fit. To me it does not seem likely that it would ever be necessary to use that because you would not run along enough under water to use up the air that is in the boat before coming to the surface, and when you do that you get a fresh supply of air.

Mr. Cummings: How long do you think she would run under water without coming to the surface?

Lieutenant Caldwell: You mean without using the compressed air? I think she would run as long as her electricity would last—as long as her motive power would last. I do not see any necessity for that however.

Mr. Cummings: Suppose a battleship five miles off and the submarine boat lay in the river. Would you come to the surface going towards the battleship?

Lieutenant Caldwell: You would have to come to the surface very frequently to see where you are steering—if in the river especially; if on a straight course not so often, but if

crooked you would have to come to the surface pretty often to steer.

Mr. Hawley: My understanding is that they steer by compass, and once steered straight they managed their direction without difficulty.

Lieutenant Caldwell: Yes, sir, that is correct.

Mr. Hawley: Then, why do you find it important to come to the surface?

Lieutenant Caldwell: The curve of the river.

Mr. Hawley: Suppose you were in the open bay, as Mr. Cummings says, five miles distant from a battleship and the coast perfectly clear, traversing the entire distance between your initial or starting point and the vessel, would you then be obliged to come to the surface?

Lieutenant Caldwell: In theory you would not, but in practice I think you would on account of tide and currents.

Mr. Hawley: Well, how far would you travel under water without coming to the surface?

Lieutenant Caldwell: If you had a perfectly plain course and your target stationary, I would not consider it necessary to come to the surface until about a mile from the target.

Mr. Hawley: You would run four miles under water?

Lieutenant Caldwell: Yes, sir. Come up then to see if I were going straight to run the thing down. The steering is by compass. The compass is well compensated for deviation, and it works very well.

The Chairman: Is it efficient? Can you turn it quickly and rapidly?

Lieutenant Caldwell: It turns beautifully; yes, sir. That was done on this trial of the fourteenth of March. She was turned under water after firing the torpedo, and came back in the opposite direction.

Mr. Cummings: In the report of Admiral Rogers—'but the steering and diving gear did not work satisfactorily owing, it is believed, to the inexperience of the crew.' What was your experience in regard to the steering and diving gear?

Lieutenant Caldwell: I can readily see how with an inexperienced crew she would steer very erratically. You will have to have well trained men, but there is no difficulty;

there are plenty of men available to be trained. I do not think that presents any difficulty.

Mr. Cummings: They say 'the apparatus for ensuring a steady course during the run below water was not used.' That is in the report of the Rogers' Board. Was it used while you were on board of her?

Lieutenant Caldwell: I do not know what that apparatus is. The steering engine was used.

Mr. Cummings: The Board also says: 'Steadiness of movement in horizontal and vertical planes unsatisfactory.' Did you find it so?

Lieutenant Caldwell: Not at all. It was perfectly satisfactory. Very well done. It was simply skilful steering. The same way if we had a man at the helm who is not a good quartermaster or seaman the ship is not well steered; she does not steer a good course. The same way in this, you will have to have a well trained man.

Mr. Cummings: Those were the only faults, if they were faults, that were found by the Board.

Mr. Frost: They say in the latter report that there was much improvement in it generally, so they were corrected.

Mr. Cummings: If the Lieutenant would tell me exactly what he did when he went on that boat up to the time he went in this trial trip.

Lieutenant Caldwell: I did nothing at all except to sit quietly on a stool and watch the manipulation of the boat. You can see it all, it is all open. You can see what every man is doing except the engineer who is a little hidden from this big room. It is a very good post of observation. We went in, and as I say, each man was at his station.

Mr. Cummings: Is it all one room below?

Lieutenant Caldwell: It is all one room. Yes, sir. Each man has his station sitting on a stool. I took a position where I could watch the pressure gauge and watch the immersion. I could not have told sometimes if we were on the water or below if I had not watched that gauge, and I watched this man steering the second man I spoke of. He had nothing to do but work this little wheel which regulates the immersion and you saw how well it was done because

the flags were kept on a level with the water and I could see from the gauge that we kept very well on level with a variation of perhaps three—no—not so much as that. The captain stood on these steps under the tower with his head in the tower and steered the boat and also gave the orders about going ahead, when to dive and when to come up, and about filling the tanks, and generally about running the boat. The other men were stationed at apparatus or at the tanks, and the engineer had the engine running electrically.

Mr. Cummings: She had electric lights?

Lieutenant Caldwell: Electric lights all through, well lighted. As I say the air was always good. I didn't have any difficulty about breathing. When it became time to fire the torpedo that was fired by the man stationed at the forward trimming tank without any difficulty.

Mr. Cummings: Was it fired from a gun?

Lieutenant Caldwell: It was fired from a torpedo discharging tube, the same as is used on torpedo boats. It may be called a gun but it is fired by compressed air.

Mr. Cummings: Was it placed in the gun while you were there?

Lieutenant Caldwell: It was already in the gun. It was the only torpedo that was on board but it was very easy to see how they could be placed in the gun. There is no mechanical difficulty in that. They can carry on the present 'Holland,' they say three. The captain tells me that. I don't see any reason why they could not have four back there in that place.

Mr. Cummings: What torpedo was it?

Lieutenant Caldwell: The White-head.

Mr. Cummings: What will it weigh?

Lieutenant Caldwell: It weighs about eight hundred and forty pounds.

Mr. Cummings: After the discharge did it affect the boat any?

Lieutenant Caldwell: Not in the least. There was a very slight shock. They had a very ingenious scheme of automatically filling a tank forward with enough water, just the weight of the torpedo, so that when the torpedo is charged that will allow this water to take the place of the torpedo in the tube,

and it does not affect the stability at all. That works very well.

Mr. Loudenslager: Lieutenant, it seems to me most of the testimony we have had here, has been demonstrating the efficiency of this boat as a submarine boat.

Lieutenant Caldwell: Yes, sir.

Mr. Loudenslager: I want, if possible, to try to get at the efficiency of this boat as a fleet destroyer. Have you ever witnessed an experiment where the torpedo was discharged at a target?

Lieutenant Caldwell: No, sir.

Mr. Loudenslager: Have you ever read where they have had such experiments?

Lieutenant Caldwell: I have not read of any actual experiments. I have some knowledge of ships being destroyed in battle by torpedoes.

Mr. Loudenslager: By this boat?

Lieutenant Caldwell: No; by torpedoes discharged from above water.

Mr. Loudenslager: I am speaking about the efficiency of the 'Holland' to discharge one at a target and make it effective.

Lieutenant Caldwell: I do not know of any experiments that have ever been made because torpedoes are so expensive.

A Member: And ships are expensive.

Lieutenant Caldwell: A torpedo costs about twenty-five hundred dollars. Something about that. I have seen them just running with dummy heads.

Mr. Loudenslager: In order to show her efficiency, is her machinery such as to make you believe that it would be possible to discharge that torpedo at a given target and destroy it?

Lieutenant Caldwell: She has discharged a torpedo at a target. It is a well-known fact that a torpedo if it strikes will blow up any ship there is. I think the experiment is just as good to discharge a dummy torpedo and let it run at some mark.

Mr. Loudenslager: Was this successful?

Lieutenant Caldwell: They did not discharge it at a mark

on this occasion, but on the test by the Board of Inspection, the official test of it, they were very successful.

Mr. Loudenslager: They discharged a torpedo at a mark?

Lieutenant Caldwell: Yes, sir.

Mr. Loudenslager: They struck the mark?

Lieutenant Caldwell: Yes, sir; they struck between the flags.

Mr. Loudenslager: And that course was marked by several buoys, three hundred feet apart and which——

Lieutenant Caldwell: That is approximately the length of a ship.

Mr. Lousdenslager: I want to get at your judgment as to what would be the chances of destruction of either one or the other of the boats. This submarine boat has to come to the surface to discharge a torpedo. What chances are there of a battleship or cruiser destroying it as it comes to the surface?

Lieutenant Caldwell: Not one in a million, sir.

Mr. Loudenslager: Doesn't it for a long period carry a mark on the water to show where it is?

Lieutenant Caldwell: No, sir.

Mr. Loudenslager: Doesn't it have a mast?

Lieutenant Caldwell: No, sir, they had the masts simply to shew the people in these tests.

Mr. Loudenslager: Nothing would be shown.

Lieutenant Caldwell: No, sir. When she did show her turret, that would be all that would be shewn.

Mr. Loudenslager: That would be for the person who discharged the torpedo to come up and get his range?

Lieutenant Caldwell: Range does not enter into it. It is a question of direction.

Mr. Loudenslager: He would have to find his direction?

Lieutenant Caldwell: Yes, sir. That is the way the boat would look in the time of action. It would not have any masts at all and would not have that funnel (indicating the funnel on the model before the Committee).

Mr. Hawley: What is the displacement of this boat?

Lieutenant Caldwell: The displacement of the 'Holland' is seventy-four tons. I understand the displacement of this boat is to be somewhat larger.

Mr. Hawley: I would like you to make a statement in regard to one of these boats being carried by a larger one.

Lieutenant Caldwell: I saw in actual practice in a Russian armoured cruiser in the East—I have forgotten her name—but she had a compartment in her quarter in which she hauled out a torpedo boat and then launched it out, cut out about the water's edge, just about like launching off the stocks. If you want to transport these vessels on a man-of-war, of course they would take up considerable room, but you can build a special transport ship and carry them.

Mr. Hawley: At what distance can you make these torpedoes effective?

Lieutenant Caldwell: There is a good deal of question about that. It is somewhere between 400 and 800 yards. They say there is no difficulty about its running 800 yards, but the chances of hitting are so much less I would rather be about 4 or 500 yards before discharging.

Mr. Hawley: Would it be effective at 4 or 500 yards?

Lieutenant Caldwell: Yes, sir; it would be effective. The nearer you get, the more chances of hitting the target.

Mr. Hawley: In your experience have you examined the coast defence of our country — I mean not critically, but generally,—and do you consider the construction of these boats as rendering it unnecessary to build on the large scale as now in progress and projected our coast defences on land?

Lieutenant Caldwell: I think what this boat takes the place of more than anything else is submarine mines and torpedoes. I am not prepared to say about whether or not it will take the place of the land fortifications.

Mr. Hawley: Even to the extent of modifying them in some degree?

Lieutenant Caldwell: I do not know about that, but what it will take the place of is submarine mines and torpedoes.

Mr. Kitchen: Lieutenant, I just wish to call your attention to a statement that Captain John Lowe made in a letter to the Secretary of the Navy, November 7, 1899, in which he said, 'We need right off and right now fifty submarine torpedo vessels in Long Island Sound to preserve the peace and give potency to our diplomacy.' Do you think it would take

fifty in Long Island Sound, and, if so, how many do you think it would take for our complete coast defence?

Lieutenant Caldwell: No, sir, I do not. I cannot conceive that he meant fifty for Long Island Sound alone.

Statement of Mr. John P. Holland.

The Chairman: Now, gentlemen, we have the inventor of this torpedo boat here, Mr. Holland himself, and if he will come forward we will be glad to have him add anything he may want to or may think desirable to this Committee.

Mr. Cummings: Mr. Holland, I would like to have you detail specifically what you consider the strong points of your submarine boat.

Mr. Holland: Its power of secret approach and attack are its strongest points, and to these I may add that its attack when driven home is irresistible, that is, its torpedo exploding against a ship.

Mr. Cummings: How long have you been experimenting on your boat, Mr. Holland?

Mr. Holland: I have been experimenting since 1877.

Mr. Cummings: When did you launch the first submarine boat?

Mr. Holland: January, 1878.

Mr. Cummings: That was in New York Harbour?

Mr. Holland: No, sir, that was in the Passaic River, above the bridge, Paterson, N.J.

Mr. Cummings: When was it you were conducting your experiments in New York Harbour?

Mr. Holland: 1881, 1882 and 1883 with my second vessel.

Mr. Cummings: Was there one time there when you discontinued your experiments?

Mr. Holland: There were three occasions when I discontinued my experiments and abandoned them definitely. The first time on the advice of a naval officer, the late Admiral Simpson, who advised me to give it up. I gave it up, but some friends supplied money, and I built my first vessel. Later they supplied money to build a second. It was entirely successful in almost every respect, but it was rather small.

It was only thirty-one feet long and six feet in diameter, with about nineteen tons displacement. Later I built the third one as a working model for the 'Holland' and I experimented with these two in New York Harbour, mostly with the second one. It was just as successful in its way as the 'Holland' has been, only that we did not at that time have storage batteries. They were not in existence. The storage battery has practically rendered submarine navigation possible.

Mr. Cummings: Did the Navy Department take any interest in your experiments?

Mr. Holland: No, sir, never paid any attention whatever to it, but about a year or two after the close of my experiments some officers in the navy there, professionally interested, endeavoured to find out all about it, and amongst them was Commander Kimball, and I had several interviews with him and he was very much surprised to hear what stage of development it had attained. He had no idea it had done so well. He interested his colleagues in the Bureau of Ordnance, Captain Converse and Captain Maynard, and they interested the Chief of the Bureau of Ordnance, who is now Admiral Sicard, and they got an appropriation from the Secretary of the Navy to build a submarine boat out of two million dollars placed in his hands to be expended for the purposes of harbour and coast defence at his will or in his judgment. That appropriation was placed in the hands of the Secretary of the Navy, and they advertised for bids for submarine boats, inviting everybody, mechanical engineers or naval engineers and architects, not alone Americans, to compete, taking in the rest of the world. The chief of them was Nordenfelt, the inventor of the Nordenfelt gun and builder of four submarine boats before that time. And they had the competition and I won it and though I did win it, I did not get it because of an informality in the bid by the persons who bid for me. They were the Cramps. They made no deposit. I left everything to them. They did not give any guarantee, and although I won in the competition, I did not get it.

Mr. Cummings: What other boats were competing with you?

Mr. Holland: Nordenfelt and two others. I don't re-

member the names of the others. I think Mr. Baker, who afterwards built a boat in Lake Erie, was one of them. The next year they advertised another competition, and there were several plans proposed, and I won it, but, as in the first case, I didn't get the money that year either, because it was wanted for the completion of the Monterey, so it was dropped. That was the second time I abandoned the submarine boat.

Mr. Cummings: Who was the Secretary of the Navy then?

Mr. Holland: The one that succeeded Whitney, General Tracey.

The Chairman: When was it, Mr. Holland, you entered into this present contract with the Government, and what is the arrangement between you and the Government by which you are building this present boat—the 'Holland' and the 'Plunger'?

Mr Holland: The Government had nothing to do with the building of the 'Holland' except to send an officer to see what was done in its progress.

The Chairman: The Government has no interest in the 'Holland'?

Mr. Holland: Not yet.

The Chairman: How about the 'Plunger'? Is that being built according to your plans.

Mr. Holland: Yes, sir. She was contracted for in 1895, after third competition, which I won against all comers. She was contracted for in 1895, and we were unfortunate in our contract in the parties who took it, because they were too slow—the first builders that entered into the construction of the boat—and it dragged on for years, and finally we got permission at the Navy Department to remove it and we took it away and sent it to Triggs Works in Richmond. We expect to finish it now in short order—something like six months—that belongs to the Government.

Mr. Cummings: You say there is some legislation under which the Government was to take the 'Holland' provided you filled the required specification?

Mr. Holland: Yes, sir. There was in 1896. Congress voted to appropriate $350,000 for two boats on the model of the Plunger, provided that she would meet the requirements

of the Government. In 1898 we had that law modified, because we discovered by the experience of the 'Holland' that she was a superior type of boat, very much better than the 'Plunger,' and we asked Congress to substitute the 'Holland' for the 'Plunger'; so there is an appropriation standing now for the two boats. With part of that appropriation the Secretary of the Navy proposes to buy the 'Holland' and we expect that he will order or contract with us for another new one of the type of this number seven which is a little larger that the 'Holland,' one hundred and twenty tons displacement; the other is only seventy-five, six feet longer and very much more roomy, and it carries five torpedoes instead of three.

Mr. Cummings: Here is the clause in the Naval Appropriation Bill approved June 10, 1896.

'The Secretary of the Navy is hereby authorised to contract for the building of two submarine torpedo boats of the 'Holland' type, at a cost not exceeding one hundred and seventy-five thousand dollars each; said boats to be constructed and delivered to the Navy Department within four months from the date of contract; PROVIDED that the 'Holland' boat now being built for the Department shall be accepted by the Department as fulfilling all the requirements of the Contract, and as being satisfactory to the Secretary of the Navy; but no action shall be taken therein until said 'Holland' boat now being built for the Department shall have been fully tested to the satisfaction of the Secretary of the Navy and thereupon accepted.'

Mr. Holland: That is the 'Plunger.'

Mr. Cummings: That 'Holland' type?

Mr. Holland: That was the 'Plunger.'

Mr. Cummings: Was there subsequent legislation to that?

Mr. Holland: Yes, sir. The boat in the meantime was named by the Government the 'Plunger,' and we asked Congress to have the 'Holland,' as my folks named my boat, set aside for them as soon as the 'Holland' was perfected so that it was all that was required and acceptable and the other appropriation would be made available.

Mr. Cummings: So it stands to-day as the Navy Department have reported that all the requirements have been fulfilled?

Mr. Holland: Yes, sir.

Mr. Cummings: So that we will purchase this boat with the additional provision for building another of the same type?

Mr. Holland: Slightly altered. We call this and the 'Holland' the same type. This is the 'Holland' with its defects eliminated. There are some defects eliminated, and, as far as we know, we have eliminated them. The boat is a little longer, and she has much more power. She will have 180 horse-power for surface running instead of 50, and 70 electric horse-power for running submerged instead of only 50 on the 'Holland.'

Mr. Cummings: Let me get at this. You are not required to build submarine boats for the United States Government alone?

Mr. Holland: No, sir; we are not.

Mr. Cummings: You can build them for whom you please?

Mr. Holland: For whom we please, because some of our patents are published in foreign countries.

The Chairman: You are a citizen of the United States, Mr. Holland?

Mr. Holland: Oh, yes, sir; I am a citizen.

The Chairman: And you are in a position if the Government desires, to construct for them as many as twenty of these boats and allow the Government to control the secret?

Mr. Holland: Well, I am in a position to do it, and am ready to contract to do it, but the Navy Department has not asked me about it.

The Chairman: You are building the 'Plunger' now? You have no works of your own, but do it by contract?

Mr. Holland: By sub-contract.

The Chairman: And you would be in a position to make a contract with this Government whereby this Government will control this process or your plant?

Mr. Holland: Yes, sir. By the way, what the Government asked to control was only the American patents. They have not made us any proposition at all to buy the sole right out. My Company is perfectly willing to do it in case they make us an acceptable proposition.

Mr. Wheeler: Have you made any to the Government?

Mr. Holland: No, sir.

Mr. Wheeler: What would be the advantage to the Government of controlling your process if you had foreign patents by which the Governments are advised of the construction and mechanism of the ship?

Mr. Holland: The advantage to the Government would be only the saving in the expense of building.

Mr. Loudenslager: Does your transfer to the Government transfer all rights under foreign patents?

Mr. Holland: They have never asked us to do that.

Mr. Loudenslager: Would you be willing to transfer to this Government all rights under all patents?

Mr. Holland: I will be only too glad if the Government will do it.

Mr. Cummings: I will put in evidence, Mr. Chairman, the two reports.

LETTER
OF THE
HOLLAND TORPEDO BOAT COMPANY.

Dated, January 25, 1901.
Addressed to
HON. EUGENE HALE
(Chairman of the Committee on Naval Affairs, U.S. Senate).

In support of an Amendment to the Naval Appropriation Bill providing for Seven Submarine Boats of the 'Holland' type.

Offices of the Holland Torpedo Boat Company,
43 and 45, Corcoran Building,
Washington, D.C.,
January 25th, 1901.

Hon. Eugene Hale,
Chairman of the Committee on Naval Affairs,
U.S. Senate.

Dear Sir,

We respectfully request that your Committee will insert the following amendment in the Naval Appropriation Bill, viz. :—

AMENDMENT TO THE NAVAL APPROPRIATION BILL, PROVIDING FOR SEVEN 'HOLLAND' BOATS.

'That the Secretary of the Navy is hereby authorised and directed to contract for seven submarine boats of the Holland type, similar in design, dimensions and other respects to the six Holland boats contracted for by the Secretary of the Navy on August 25, 1900, and to the one contracted for by the Secretary of the Navy, November 19, 1900. Provided, That no contract shall be entered into for the submarine boats herein provided for until the first of the six submarine boats contracted for by the Secretary of the Navy on August 25, 1900, shall have been found by the official trials to comply with all of the contract requirements and been accepted by the Secretary of the Navy as working to his satisfaction. Provided further, That the price to be paid for each boat shall in no event exceed $170,000, the maximum price agreed on between the Secretary of the Navy and the Holland Company April 11, 1900; said agreement being printed in Senate Document No. 321, 56th Congress, 1st Session.'

Your Committee is aware that the Secretary of the Navy purchased the 'Holland' from this Company during the last session of Congress, after the exhibitions of that boat given to the Navy Department officials and the Naval Committees of the House and Senate.

The 'Holland' was sent to the Torpedo Station at Newport by the Secretary with instructions to have her thoroughly tested by officers of the Navy, and that a naval crew might be trained in her use.

We gave the services of our naval engineer, Captain Cable, and our trained crew to the Department, free of cost to the Government, until the Department notified us that its officers and crew were thoroughly trained and did not need the services of our experts any longer.

Our experts and trained crew were used by the Government at our expense for about three months in this service.

The reports of the performance of the 'Holland' during the naval manœuvres at Newport are a matter of public and general notoriety.

Lieutenant Caldwell commanded the 'Holland' during her night attack upon the blockading fleet. She went seven miles to sea at night and torpedoed the flagship of the Squadron, the 'Kearsarge,' commanded by Captain William M. Folger, formerly Chief of Ordnance of the United States Navy.

The reports to the Department of these officers, who witnessed this attack, are in the highest degree complimentary to the 'Holland' as a war vessel for coast and harbour defence, and the reports of all the officers of the Navy who have witnessed the performances of the 'Holland' at Newport are unequalled for unanimity in praise of her efficiency and high value as a vessel of war.

The following article, taken from 'The Daily Times' of the City of Troy, New York, of December 22nd last, gives the opinion of Commander Richard Wainwright, U.S.N., of the 'Holland's' military value. Commander Wainwright has charge of the 'Holland' at present as Superintendent of the Naval Academy at Annapolis. It will be remembered that Commander Wainwright was executive officer of the 'Maine,' when she was blown up, and distinguished himself afterwards, while in command of the 'Gloucester,' by destroying the torpedo fleet of the Spanish Navy at Santiago.

Referring to the Naval Academy, the article says:—

'The 'Holland' has been visited by nearly every student at the Academy, as well as the officers; and Commander 'Dick' Wainwright of the 'Gloucester,' who so fearlessly fought the 'Furor,' and the 'Pluton' off Santiago, in July, 1898, has himself taken quite an extended trip in that wonderful little vessel, which travels as well under water as on top of it. Commander Wainwright was asked what he thought of the 'Holland' as an addition to a modern navy. 'The 'Holland' is all right,' he replied. 'She will never revolutionize modern warfare, but no vessel will ever do that. But for coast defence purposes she is of inestimable value as an

addition to our Navy. Too much cannot be said in her praise.' Commander Wainwright is the Superintendent of the Academy. All the cadets under his care take great interest in this latest addition to the science of naval warfare, and there is not one of the whole corps who is not anxious to command this vessel in a practical test as to her ability to cope with a vessel of a hundred times her size.'

The following is the

Testimony of Commander Richard Wainwright.

Superintendent of the Naval Academy, as to a Trip in the 'Holland,' and the military value of submarine boats. Commander Wainwright was heard by the House Committee on Naval Affairs in December last.

Mr. Cummings: You have the submarine boat at Annapolis?

Commander Wainwright: Yes, sir.

Mr. Cummings: How long has she been there?

Commander Wainwright: About two months I think.

Mr. Cummings: Have you had any experience with her?

Commander Wainwright: Yes, sir; I went down on her. We went out into the bay.

Mr. Cummings: How far?

Commander Wainwright: Out into the deep water.

Mr. Cummings: Six or seven miles?

Commander Wainwright: Five or six miles.

Mr. Cummings: How did she work?

Commander Wainwright: Beautifully. I was very much surprised. I followed the boat for a good many years, the plans as they were growing, but I was very much surprised to see how well she can be handled. Of course Lieutenant Caldwell is an expert.

Mr. Cummings: Who went with you?

Commander Wainwright: Lieutenant Caldwell and his regular crew who handle her.

Mr. Loudenslager: What is your opinion as to the degree of efficiency she will obtain?

Commander Wainwright: I think she is an excellent harbour-defence boat.

Mr. Dayton: What speed does she make under water?

Commander Wainwright: About five or six knots. She makes all the speed you can use under water.

Mr. Dayton: What speed does she make on the water?

Commander Wainwright: She makes a little over eight knots. That is about as much as they can hope for with a submerged boat.

The Chairman: How long does she stay under water at one time?

Commander Wainwright: I do not know. She is practically under water most of the time, but she should do fighting when awash.

The Chairman: How far did you travel on her?

Commander Wainwright: We went slowly until we came to the deep water, and then we went down twelve or thirteen feet. Her nose was lower than that. Lieutenant Caldwell wanted to show me how she could dive. She made what I call porpoise dives. She steers beautifully.

The Chairman: Were you ever out in rough weather with her?

Commander Wainwright: No, sir.

The Chairman: Do you know how she will stand rough weather?

Commander Wainwright: I do not see how that should bother her—that is awash.

The Chairman: You have to come up every little while to get air?

Commander Wainwright: You can run awash and run a long time, because you can open up and take the air down and shut up again. I do not mean to sink her completely under water.

Mr. Loudenslager: What do you think is the greatest point of efficiency?

Commander Wainwright: When she is awash. Then she is just barely out of water, and she would be very hard to destroy by any large boat. She will only dive when the small boats are after her. I think she is the best harbour torpedo-boat built. I would not mind trying her at daytime.

Mr. Cummings: You mean against the enemy?

Commander Wainwright: Yes, sir; after I could handle

her as well as Lieutenant Caldwell does, and when you know that you have good men on her, because you cannot see what they are doing.

Mr. Cummings: These men have been trained for that particular service?

Commander Wainwright: Yes, sir; the object of having her at the Naval Academy is that more men and officers may see her.

The Chairman: All the crew are volunteers?

Commander Wainwright: Yes, sir; I think they should be paid a special price for their work. The men will get dissatisfied, and they want something to encourage them. At the present time only volunteers do that work. You would be surprised how little discomfort there is in going down on her.

Mr. Loudenslager: Have there ever been any trials with guns and an imaginary foe?

Commander Wainwright: Yes, sir; they tried her at Newport. They tried her at night; they cannot see her at night very well; even the searchlight will not show her up well.

The following letter from Lieutenant Caldwell, the Commander of the 'Holland' is conclusive evidence of the great value of this submarine boat to our country, with its immense coast line and innumerable harbours and ports to defend:—

U.S.S. 'Holland,'
Navy Yard, Norfolk Va.,
January 12, 1901.

Dear Sir,

Replying to your letter of the 11th instant, I take pleasure in answering your questions as follows:—

1Q. How long have you commanded the 'Holland'?

A. The 'Holland' has been under my charge from June 25, 1900, to the present time. She was formally placed in commission under my command on Oct. 12, 1900.

2 Q. What is the longest submerged run you have made in her?

A. About one and one-half miles.

3 Q. Do you consider her durable, habitable and reliable as a vessel of war for coast and harbour defence?

A. Yes.

4 Q. Commander Mason, of the Torpedo Station, says in a report to the Secretary: 'During the late combined manœuvres of the fleet, shore defences, and the torpedo flotilla, the 'Holland' made a successful attack upon the fleet at night by herself, without convoy, at a distance of seven miles out from the mouth of the harbour, and with the naval crew alone in her.' Did you command the 'Holland' upon this occasion? If so, describe how you made the attack and whether you considered it a success?

A. The 'Holland' was under my command on the occasion mentioned. She left the Torpedo Station at sundown and was placed in a partially submerged condition with the turret and about six inches of the hull above water, ready to dive at short notice. Cruised in this condition to S'd and E'd of Brenton's Reef Lightship. Sighted two vessels of blockading fleet and fired torpedo signal at them, but was not answered, and they disappeared before I could ascertain their identity. About 9 p.m., about seven SSE. from harbour entrance, sighted U.S.S. 'Kearsage' within range and fired torpedo signal. Followed her and getting within 100 yards without being discovered, showed light, hailed her and informed her commanding officer that she had been torpedoed. The 'Holland' was not seen by any vessel of the blockading fleet or torpedo boat, although she was within range of three of the former and several of the latter. I consider that the attack was a success because the 'Holland' could in all probability have torpedoed three blockading vessels without being discovered.

5 Q. Please give your opinion as to the value of the 'Holland' as a coast and harbour defence vessel.

A. I consider her of very great value for that purpose.

6 Q. Would you be willing to command her in case of war with a foreign power that was blockading some of our ports, and harbours, and if so what do you believe you could do with her towards breaking the blockade?

A. Yes. I believe that I could sink one or more vessels of a blockading fleet or else make them keep so far away as to make the blockading ineffective.

7 Q. Do you believe, with six of the 'Holland' boats

under your command, having trained crews composed of American men and officered by men of your selection, that you could break a blockade of New York City made by fifteen ships of war? If so, describe how you would do it.

A. Yes; by direct night attacks, approaching the fleet from different directions in partially submerged condition and diving when discovered. If the fleet kept underway, by lying in wait at different points of its course or accompanying a decoy blockade runner.

8 Q. Would it not be a wise provision for the Government to build from five to ten of these 'Holland' boats this year, in addition to the seven now under construction, and distribute them among our principal ports and harbours in case of war?

A. In my opinion, decidedly yes.

9 Q. From your experience in command of the 'Holland' can she go ten miles or more to sea and make a successful attack on an enemy's fleet by day or night?

A. By night, undoubtedly; by day, in all probability.

10 Q. How is it proposed to take the 'Holland' back from Norfolk; and if unable to return under her own power, explain why.

A. I am not officially informed how the Navy Department proposes to return the 'Holland' to Annapolis. She could return under her own power, though I should not consider it advisable, as her main motor is disabled, through an armature bar being burned out, so that she cannot back. She made the last sixty miles of her voyage from Annapolis under this condition.

Very respectfully,
(Signed) H. H. CALDWELL,
Lieut. U.S.N., Navy Commanding.

Hon. R. B. Hawley,
Committee on Naval Affairs,
House of Representatives.

We ask the careful attention of your Committee to the following:

TESTIMONY OF ADMIRAL PHILIP HICHBORN,

Chief Constructor U.S. Navy, before the House Committee on Navy Affairs, recommending additional 'Holland' Boats and certifying to military value of same, January 11, 1901.

The Chairman: Admiral, you are here at the request and invitation of the Committee, and we would be pleased to have you speak freely and frankly in regard to the matter.

Admiral Hichborn: I am very much obliged to you. I gave testimony before this Committee, which I have brought with me, and it seems to me you gentlemen can gain time and reduce it down to a very few words by asking me questions as to whether I still adhere to that opinion as expressed in that document, instead of going over the details again and wearying you with them. You all recollect what it is. It is a printed document before this Committee.

The Chairman: It is the testimony of Rear-Admiral Philip Hichborn, taken by the House Committee on Naval Affairs on April 23, 1900. You would like to have this made a part of your statement?

Admiral Hichborn: Yes; I would like to reiterate that testimony.

Mr. Wheeler: Just state briefly and concisely the contents of the hearing please. Do not state it in detail, but state it briefly.

Admiral Hichborn: One of the particular items that probably interests you the most is as to the number of the boats?

Mr. Hawley: You answered, Admiral, that seven boats are now in course of construction. Do you mean the additional number of boats which the Government ordered to be built or required?

Admiral Hichborn: My answer to the question how many at the present time should the Government build, is twenty.

Mr. Hawley: Since that time have you had any oppor-

tunities to observe the 'Holland' or to inform yourself further with respect to her?

Admiral Hichborn: The same as all other officers of the Service,—by reading the reports, by reading of the manœuvres at Newport, and following her up in a general way.

Mr. Hawley: Do you regard the construction of the 'Holland' now as a naval war vessel as an experiment?

Admiral Hichborn: No, sir; I stated in this report that at that time she had passed the experimental stage.

Mr. Hawley: Has your observation and information since then confirmed you in that opinion?

Admiral Hichborn: Fully.

Mr. Wheeler: What about this French boat? Have you any information on that subject?

Admiral Hichborn: I have no more information than the reading public generally has, and what comes to the Navy Department. The French guard all their secrets very carefully. But to my mind she is not a success. They are evidently experimenting with her, and I consider her in an experimental stage.

Mr. Rixey: I understand your opinion is, Admiral, that this 'Holland' boat is a valuable addition to the Navy?

Admiral Hichborn: I do.

Mr. Rixey: Now I understand we have and are building seven boats. How many do you think we ought to have?

Admiral Hichborn: If we build seven this year we ought to build six or seven next year, but do not let it stop. As you are building seven this year, repeat that next year, the same as you would do in building ships. You do not order all your building program at once. But if war was threatening us, that would not be a drop in the bucket.

Mr. Hawley: If war was threatened and war should come, would we then have time to prepare, after the exigency had arisen, these torpedo boats for coast defence?

Admiral Hichborn: In modern warfare, unless you are ready when war commences, you will never get ready afterwards.

Mr. Hawley: The purpose of these boats, of course, is for coast defence, and they should be located at the most important and valuable ports of our country, those that the

enemy would most promptly attack if they were made accessible to them?

Admiral Hichborn: Yes.

Mr. Hawley: How many of these boats would be required, do you think, for the larger harbours and larger cities of our country; for instance, Boston and New York?

Admiral Hichborn: At the present time, I should say about two to the large ports, but that would be a small number.

Mr. Hawley: Would you think two sufficient in the case of a war with a great power?

Admiral Hichborn: No.

Mr. Hawley: You think it would be a mere aggravation?

Admiral Hichborn: It would be a help to nervous people. We had a little experience in that regard during the last war. The people along the New England coast raided the Navy Department from morning till night for old monitors that had been condemned more than thirty years; and we took them down there and they kept quiet after that.

Mr. Hawley: It would be a cure for nervous prostration you think?

Admiral Hichborn: As good a cure for it as anything you could get.

Mr. Hawley: If these boats were stationed at the different cities, what effect would it have on the nerves of the people on a squadron blockading ports of the United States?

Admiral Hichborn: It would keep them up nights. It would keep them busy. Admiral Dewey expressed that very well. He said he could not have gone into the harbour of Manila had these submarine boats existed in that harbour.

Mr. Vandiver: If I remember right, he made that statement before this Committee last winter.

Admiral Hichborn: He said that if he had got in there and these submarine boats had existed, the nervous strain upon his officers and men would have worn them out, not knowing when an attack was going to take place.

Mr. Hawley: As a member of the Board of Construction, and a respected one, certainly, will you state clearly to the Committee the number of boats, assuming now that we have seven on the stocks, that you feel it would be a value and a greatly increased strength to the Navy to provide for now

—the number of 'Holland' boats in addition to the seven?

Admiral Hichborn: In this Bill?

Mr. Hawley: In this Bill.

Admiral Hichborn: I should say, repeat that number. That seems to be consistent.

Mr. Hawley: That would be fifteen boats?

Admiral Hichborn: That would give us fifteen. We have seven building, one in commission, and seven more to build; but you would not commence that until next July, to build those boats under this Appropriation Bill. You have to make your contracts, and that runs along for one or two months; and you would not get started on those boats for eight months probably, after you commenced them, and then it would take probably, in this busy time of shipbuilding, a year before you got them. I do not think shipbuilders would take a contract to build them much under that time, in view of the large amount of work that has been forced upon them.

Mr. Hawley: We were in better condition to go to war with Spain, as we did, than we would be to-day to go to war with any great power?

Admiral Hichborn: Yes; I do not think we are in any condition to go to war with any great power.

Mr. Hawley: In addition to your conclusions on this subject, are you familiar with the statements and conclusions of other officers of the Navy, for instance, Admiral Dewey? Do you know Admiral Farquhar's opinion on this subject?

Admiral Hichborn: Yes; I have read what he has to say, and I have read what Captain Folger has to say.

Mr. Hawley: Their opinion is favourable to this boat and its construction?

Admiral Hichborn: Yes; I place great importance upon what Captain Folger says. He used to be the Chief of Ordnance in the Navy Department for many years. He is a pretty plain-spoken man and I must say that I was rather surprised to hear his statement. I was rather pleased, because it sustained my views.

Mr. Hawley: It is very explicit.

Admiral Hichborn: When you get an expression of that kind from him you may rest assured it is pretty near correct.

Mr. Hawley: He stated it was his view that he thought the 'Holland' would play a serious and important part in all future naval warfare?

Admiral Hichborn: Yes; he thought so.

Mr. Hawley: Does the Committee gather from your statement as your fixed judgment on this whole question, Admiral, that the construction of these boats, or boats of a similar type, must inevitably become the policy of the Navy Department of this Government?

Admiral Hichborn: Which Committee do you mean; this Board?

Mr. Hawley: Do we understand that your judgment with respect to these boats is that they are of such a character and will play such a prominent and important part hereafter that it will inevitably become the policy of this Government to construct this or a similar boat?

Admiral Hichborn: Without any question. It is also my opinion that the English Government will be following it up in a very short time; and I have more than just an ordinary reason for saying that, because I have communications from some of the leading architects of the English Government who take the liberty to write to me and ask my advice. I can judge by the tone of their letters; and their whole disposition is to very soon have submarine boats. No nation can be without them. You have got to have what every other nation has.

Mr. Hawley: And a little more if you can get it.

Admiral Hichborn: Yes; more and better if you can get it. It is no new thing for inventions of this kind or changes of this kind to be made in modern warfare to meet that opposition. If you will look at the history of our Government you will find that all these undertakings have been opposed by the Navy Department and opposed by the people connected with it, and have met with great opposition; and they have to develop themselves. I heard the 'Monitor' referred to in that connection. If any one follows up the history of the 'Monitor' he will find that it took President Lincoln's order to build that vessel, the opposition was so great.

The unanimous testimony of all of these officers from the

Admiral commanding the fleet, down, is without exception the greatest tribute ever paid to any new implement of warfare, and the serious consideration of the fact is urged upon your Committee that all these officers' reports are based upon actual observation and tests, and their judgment as to the boat's merits cannot be disputed or argued away by anyone, especially by persons who have never witnessed a submerged run of the vessel or been in her during any such run. The military value of the 'Holland' has been settled and is no longer an open question.

It is hardly necessary to recall to your Committee the testimony of Admiral Dewey, given before the House Committee during the last session of Congress. Admiral Dewey saw the battle test of the 'Holland' when your Committee saw it in the Potomac River, and he gave his emphatic opinion that had two such boats as the 'Holland' been in Manila Harbour when the United States Fleet entered it the fleet could not have remained in the harbour, and 'with two of the 'Hollands' in Galveston Harbour all of the navies of the world could not blockade that place.'

If your Committee will now add to the testimony of Admiral Dewey, the greatest naval officer living, the testimony of Rear-Admiral Farquhar, commanding the North Atlantic Squadron, Captain Folger, commanding the flagship 'Kearsarge,' and Lieutenant Caldwell, the Commander of the 'Holland' that that boat can approach a battleship by night or by day unseen and blow it up, we think your Committee should not hesitate to appropriate for a number of boats of the 'Holland' class at this session of Congress.

Admiral Farquhar and Captain Folger, after personal observation, and Lieutenant Caldwell from actual tests under his direction and command, have practically said to the Navy Department, to Congress, and to the American people, that the $5,000,000 battleship 'Kearsarge' can be blown up by the 'Holland' either by day or night seven miles away from shore, for that is the distance the 'Kearsarge' was out in the ocean when Lieutenant Caldwell, in command of the 'Holland,' torpedoed her. It seems to us, therefore, that when a little weapon of such an insignificant cost as the 'Holland' can go out of our harbours *by day or by night,*

and blow up battleships of our enemies, *seven or more miles* out at sea, with insignificant danger to itself or crew, the time has arrived for our Committee to stop paying heed to hypercritical objections to her value, made by officers of the Navy who have never made a submerged run in the 'Holland' and never even witnessed one, and who are utterly opposed to the use of submarine boats in the Navy without regard to their merits.

Since the adjournment of last Congress the Secretary has contracted to build six more submarine boats of the 'Holland' type.

Now these new 'Holland' boats, it is true, are guaranteed by us to be slightly larger and to have increased horse-power for both surface and submerged running. The fundamental principles of the 'Holland' have not been changed in them; there is nothing whatever experimental in them. We have endeavoured to give the Government in these new boats, a development in speed, in some few safety appliances and in better sleeping accommodations, etc., for the crew.

The dimensions of the 'Holland' are :—Length over all, 53 feet 4 inches; diameter, 10 feet 3 inches; displacement, submerged, 75 tons. The dimensions of the new boats under construction are :—Length over all, 63 feet 4 inches; diameter 11 feet 9 inches; displacement, submerged, 120 tons. The 'Holland' is fitted with a gas engine of the Otto type of 45 horse-power, which is capable of driving the vessel on the surface at the rate of about seven knots an hour and fully submerged between five and six knots an hour. The new boats are to be fitted with engines of the Otto type developing 160 horse-power, giving a speed of about 9 knots on the surface, while it will give the boats between seven and eight knots running submerged.

Under the contract of August 25th for the building of six submarine boats now under construction, the last one is to be delivered to the Government on or before July 25, 1901. We are under heavy bonds and penalties to complete these boats within the time prescribed in the contract. We have not the least hesitancy in stating that these boats will all be delivered to the Government within the time named in the contract.

SUBMARINE NAVIGATION

The following letter has been sent to the Chairman of the House Committee by Mr. Lewis Nixon, who is building four of these boats under the contract referred to. His opinion coincides with ours that all these boats will be finished well within the contract time. We are assured by the Union Iron Works of San Francisco, who are building the two boats assigned to that coast, that there is no doubt about their completing their contract with us well within the time limit. Mr. Nixon, while an officer of the Navy in the Construction Bureau, designed the 'Oregon,' 'Massachusetts,' and 'Indiana,' and resigned to accept the position of Naval Architect of the Cramp Shipbuilding Company (a position he still holds) and superintended the construction of the 'Indiana' and 'Massachusetts' and all ships of war built by that firm since then to this date:—

Crescent Shipyard,
Elizabeth, N.J.
December 22, 1900.

Dear Sir,

At the request of the Holland Torpedo Boat Company, I have to say that I am under contract to build and deliver to the Holland Torpedo Boat Company four submarine boats of the 'Holland' type.

This work is all being energetically pushed, and I am perfectly confident that I can deliver these boats well within the time set out in my contract with the Holland Company, thus enabling the Holland Company to deliver the boats to the Government within contract time.

I have another contract with the Holland Company to build a submarine boat to take the place of the 'Plunger.' The time of delivery contracted by me with the Company is eight months.

This boat will also be delivered well within the time of my contract.

In my judgment as a constructor of these boats, and from my long experience in designing and constructing war vessels of the Government, and as the constructor of the original 'Holland' I have no doubt whatever of the endurance, habitability, durability, and reliability of these boats.

I do not think that anyone who has a knowledge of the construction of ships, will say, after an examination of the

'Holland' and an examination of the plans of these new 'Hollands,' that there is any doubt about their durability, habitability, endurance, or reliability.

These new boats are the same as the 'Holland,' the only changes being that they are a little longer and larger in diameter, therefore giving greater accommodation for the crew than the 'Holland,' having more horse-power and contain certain safety appliances which do not exist in the 'Holland'; none of these improvements is in the slightest degree experimental.

In reference to the military value of these vessels, I have to say that if from personal observation, I had not made up my mind, that reports of Admiral George Dewey, the Admiral of the Navy, Rear-Admiral Norman H. Farquhar, Commanding Officer of the North Atlantic Squadron; Captain William M. Folger, Commander of the 'Kearsarge' the flagship of that squadron, and formerly Chief of Ordnance of the Navy; Lieutenant-Commander Nathan Sargent, Commander of the 'Scorpion'; Commander Newton E. Mason, Commander of the Torpedo Station at Newport, and Lieutenant Harry H. Caldwell, Commander of the 'Holland' would have convinced me of that fact.

The fact that most of these officers who watched the manœuvres at Newport state, in their official reports, that there is no question but that the 'Holland' can by day or night approach unseen and deliver her torpedo attack upon an enemy's fleet, leaves the question of the military value of the 'Holland' type of submarine boats without any valid criticism whatever.

No type of boat in the Navy has received such crucial tests as the 'Holland.' The submarine boat to-day is further advanced in its development than any type of naval vessels that I am aware of.

I desire to say, that, in my opinion, the 'Holland,' without any improvements, is to-day the greatest vessel for harbour and coast defence ever known.

Very respectfully,

Hon. George E. Foss, (Signed) LEWIS NIXON.
Chairman Committee on Naval Affairs,
House of Representatives, Washington, D.C.

We claim now that the Government should order more of these boats during the present Congress for the following reasons:—

1st. The boats now being built have, as we have been reliably informed, assigned to the following stations: One to Boston, one to New York, one to Charleston, one for the Chesapeake Bay, and two for the Pacific Coast.

It must be clear to your Committee that the number of these boats assigned to the foregoing places is entirely inadequate for their protection; but why should those places be selected and such important ports and places as Portland, Maine, Newport, R.I., and Long Island Sound, Newport News, Norfolk, the United States Navy Yard at Portsmouth, Savannah, Ga., Wilmington, N.C., Jacksonville, Key West, Pensacola, Mobile, New Orleans, Galveston, and other places upon the Atlantic and Gulf Coasts be left unprovided for, to say nothing of the wholly inadequate provision for the Pacific Coast?

It was perfectly apparent to every intelligent citizen of the United States during the late war between the United States and Spain, that the coasts, harbours and ports of the United States were in a practically defenceless condition, and they are to-day in the same condition.

It may be said that there being no war, there is no hurry to build these submarine boats for the ports and harbours that are unprovided for; but our late experience in the war with Spain, and the history that the world teaches us, is that war comes suddenly and is not in contemplation for years, enabling each nation to prepare itself, and it is the unprotected nation that suffers most when war does come.

This Company does not expect the present Congress or the succeeding Congress to appropriate money enough for submarine boats to protect all the harbours and ports of the United States; but it does seem to us that Congress, while being conservative in the matter of appropriations of public money, should go along each year and look towards the protection of this country by conservative appropriations for this character of defence, which is admitted by all who have studied the boat or personally investigated its merits, to be

the best and cheapest method of harbour and coast defence known.

Hon. William E. Chandler, United States Senator from New Hampshire and formerly Secretary of the Navy, in an article in the 'Cosmopolitan Magazine' of October, says:—

'The submarine boat, in my opinion, has a great future before it.

'Its most effective work will be done outside the mouths or harbours, perhaps running out on the surface of the water, and then diving to attack the enemy. It may be that some time in the future, warships will carry submarine boats for torpedo service at sea. The question is chiefly one of weight; for, if such a boat can be made light enough, there is no reason why it should not be carried on the deck of a large man-o'-war, just as enormously heavy steam launches are a part of the equipment of a modern battleship.'

Lewis Nixon in a letter dated January 13, 1901, to the House Naval Committee, says:—

'Last summer, while in Europe, I discussed submarine boats with a number of the brightest men in the British Admiralty. I could see that they regarded the 'Holland' as being far in advance of any other type, and they appeared to be conversant with the French boats.

'I look to see one or more of these vessels, not only for every harbour of the United States, but to see Congress, in its wisdom, provide at least one for every battleship and cruiser, small enough to be swung by a derrick and lowered into the water before going into action. It is perfectly feasible to design a successful submarine boat for such service.'

The attention of your Committee is called to the fact that France, the acknowledged leader of the world in naval progress, has now a fleet of about thirteen submarine boats, and our information is to the effect that an appropriation has been recently made to build forty-eight more for coast defence purposes, and that country has a very much smaller coast-line to defend than we have.

The leading French technical paper, 'Le Yacht,' editorially states that the 'Holland' is the only submarine boat constructed on rational principles.

This opinion appears to be shared in by Mr. John Thorny-

croft, the great British Naval Architect and Engineer, who said, in a recent interview:—

'The Americans seem to me to have the best type of submarine that has been yet worked out. Their latest boat is rather a diving boat than a submarine. It travels upon the surface until it wishes to avoid observation, and then dives below.'

The Secretary of the Navy gave us permission last month to get all information from the Naval Intelligence Bureau it possessed concerning the French Submarine boats. From the information thus gained and from the reports of our Company's representative in Paris, we know that our 'Holland' is far superior to the French boats in speed, submerged and awash, and in all other respects, and this opinion is shared by the U.S. Naval Officers, who have examined the matter.

'Your Committee, I think, will concede that our coasts and harbours are about as defenceless to-day as they were when the war with Spain commenced. Your Committee is also aware that the ships now under construction, waiting for armour, will not be finished for several years to come, and the battleships and cruisers that have been recently contracted for cannot possibly be completed and ready for use until three or five years hence, and this statement is made by authority of the proper officer of the Navy Department. Is it not, therefore, the duty of Congress to appropriate for a number of these little boats, comparatively insignificant in cost, in order to keep our ports safe from bombardment and give the country a sense of security against danger, while the great battleships and warships are being constructed?

'The foregoing are reasons why we think the Committee should authorise more of these 'Holland' boats to be built, looking at the question solely from a Governmental standpoint. The Company's reasons for asking Congress to authorize the building of more boats and thus encouraging the development of this great American war vessel on the same lines that the battleships are being developed by the double-turret system, increase of speed, perfection of ordnance, etc., are:—

1st. The Company has spent about five hundred thousand dollars in developing the submarine boat, an invention that

is of no benefit commercially to anyone, and can only be used in the defence of the harbours and coasts of the United States. It has a trained body of engineers, electricians, officers and crews, that have been for years in the service of the Company at the Company's expense, studying and perfecting work that is only useful to the Government of the United States.

We sold the 'Holland' to the Navy Department for $150,000 in order that the Department might thoroughly test her efficiency by sham battles, cruises at sea, in Long Island Sound, and elsewhere, during all kinds of weather, and as she has been commanded by Lieutenant Caldwell ever since she was purchased and has been through heavy storms and high seas and been frequently out upon the ocean, we insist that his testimony in favour of her military value, reliability, habitability, and durability, is conclusive on these points.

The 'Holland' cost us, exclusive of any office expenses or salaries of officers, $23,661,542. We sold her to the Government for $150,000, with the understanding that she was to be thoroughly tested and every question settled about her military value, and we claim now that the testimony of the officers of the Navy who have officially and personally tested her and reported upon her, should settle all questions of this character.

We have leased for a long term of years an experimental station on Peconic Bay, where we tested the 'Holland' before submitting it to the Government. We are now erecting buildings for employés, and it is our intention to continue to develop this great war invention, which is the result of American brains entirely. We have designed and propose to build two submarine torpedo boats, weighing fifteen or sixteen tons (which weight Admiral Hichborn says can be carried on ships of war), one to be run by electrical power only, and experiment with them for the purpose of ascertaining if they cannot be carried on board of battleships and transported by rail to the Great Lakes if necessary. These little boats could successfully protect in case of an emergency, Cleveland, Detroit, Sandusky, Chicago, and the other great cities on the lakes. An enemy's fleet could go through the Welland Canal and attack those cities in forty-eight hours after a

declaration of war, and under our treaty with Great Britain, we cannot have a vessel of war there for our defence. We are not asking this Committee to appropriate one cent. for these experimental purposes. The result of giving us no appropriation at this session of Congress will be that the boats contracted for will all be delivered by July 25, 1901, and that we shall have to suspend everything for over a year, as the next appropriation will not be available until July, 1902, even should Congress appropriate for these boats at the next session.

It will be impossible for us to carry out our plans for experimenting and developing this great war invention if we are to be subjected to the 'starvation process' of no appropriation and no work and no encouragement for over one year, with no definite promise that we will get anything even then.

All the shipyards of the United States that build war vessels for the Government have been given contracts by the Navy Department within the past few weeks amounting to millions of dollars, thus giving them work for years to come, enabling them to keep their trained men and their workmen under pay, and it seems to us, outside of their own claim for recognition by the Government, that the New Jersey shipyard of Lewis Nixon, the builder of the original 'Holland' and of the new 'Hollands' for use on the Atlantic coast, should be encouraged by an appropriation for more 'Holland' boats, as we shall build most of the 'Holland' boats intended for the Atlantic coast in his yard. It is a singular fact that out of the many millions of dollars to be paid for ships contracted recently for by the Navy Department, not one dollar has been given to a New Jersey shipyard.

We claim that the 'Holland' boat, the greatest war invention now known should be kept alive and not discouraged by the Government for want of work. We do not ask this Committee, as before stated, to appropriate one cent. for experimental purposes. For every boat we build for the Navy we give the Department a bond to refund all the money paid us in partial payments, if, upon the official trials of the boat she does not come up to every requirement of the contract, and the Government draws the contract. We do

ask, however, that this Committee will not leave us entirely without any work until July one year from now. It is not fair to us, and we claim it is not just to the Government.

After the wonderful performances of the 'Holland' and its great value to the Government has been certified to by the highest naval authorities in the world, we think we should be encouraged and not discouraged by Congress.

It has been the policy of the Government to encourage shipbuilders and shipowners. It should be the policy of the Government to encourage the building of great naval inventions, especially when such an invention has by actual tests earned the approbation of every naval officer that ever witnessed its performances or made submarine runs in it.

We venture to say here that there is not one single naval officer that ever witnessed a submarine run of the 'Holland' or ever took one himself, but that will go before your Committee and recommend that more boats like the 'Holland' be constructed each year.

If there is any officer of the Navy that has ever made a submarine run in this boat or seen one of its performances that is not unqualifiedly in favour of more boats being built, we do not know him. And your Committee will find, upon examination of any officer that appears before your Committee and discourages the building of more boats of the 'Holland' type that that officer has never seen the 'Holland' run submerged, has never been in her when she has made any such runs, and personally knows not as much as the members of your Committee do about the practical performance of the boat and is opposed to use of submarine boats in the Navy, irrespective of their capabilities.

We have your attention to the following letter from the Secretary of the Navy:—

Navy Department,
Washington,
January 9, 1901.

Sir,

The Department has considered the suggestions contained in your letter of the 24th ultimo, respecting the advisability, upon the basis of our present experience and experimentation with such boats, of authorising the purchase of several addi-

tional submarine torpedo boats of the 'Holland' type, and forward herewith a copy of report of the Board on Construction, to which your letter was referred. You are also referred to Senate Document No. 71 of the present session of Congress, which contains copies of and extracts from copies of the reports relating to such boats.

The question with the Department is not so much the desirability of submarine boats. This may be regarded as largely settled by the fact that one is now in commission and has given promise of great possible efficiency, and that seven more have been authorised by Act of Congress and are now in process of construction, although like many other new inventions they cannot be said to have entirely passed the experimental stage in respect to actual service.

The question with the Department is rather whether the construction of an additional number should be authorised until those now under construction are finished and their usefulness further assured. On this ground, there being no pressing exigency for more, and especially in view of the large naval expenditures in hand estimated for, the Department does not regard further expenditure in this direction essential at this time.

Very respectfully,

JOHN D. LONG,
Secretary.

Hon. George Edmund Foss,
Chairman Committee on Naval Affairs,
House of Representatives.

Your Committee will perceive the Secretary considers the question of the advisability of having more 'Holland' boats in the Navy as settled in its favour, but recommends waiting till the new boats now under construction are finished before more are authorised. The amendment we ask your Committee to insert in the Naval Bill provides that the boats we now ask for shall not be contracted for till the first one of the boats now building be accepted by the Secretary as coming up to all the contract requirements and shall work to his satisfaction. As the six boats are all alike the trial of one is sufficient to ascertain the usefulness of all.

The following are the trial clauses in our contract for the six boats now under construction:—

TRIALS.

'Eight. When said submarine torpedo boats shall be completed in every respect and ready for delivery to the United States as aforesaid, each of them shall be subjected to tests and trials to show its capability of making surface runs awash, and submerged runs, the former for a distance of ten nautical miles at a speed of seven knots an hour, and the latter for a distance of two nautical miles at a speed of seven knots an hour. At the end of a submerged run a service torpedo boat shall be discharged, and shall strike a target 150 feet long by 16 feet deep, the upper edge of said target being awash and placed at right angles to the course. During these submerged runs the vessel shall not come to the surface more than three times, from the time of starting until the discharge of the torpedo, the duration of each appearance not to exceed one minute.

'This and such other reasonable tests as may be required by the Department in order to fully demonstrate the successful operation of the vessel and all its appurtenances, and the fulfilment of the specified guarantees, shall be made by and at the expense of the party of the first part under the supervision of a Board appointed by the Secretary of the Navy.

'And said vessels shall fulfil the following conditions:—

'REQUIREMENTS.

'1. The working of all the machinery, devices, appliances and appurtenances in all parts thereof shall be to the satisfaction of the Secretary of the Navy.

'SPEED.

'2 The party of the first part hereby guarantees that the speed developed by said vessels upon trial under conditions prescribed by Secretary of the Navy shall be not

less than an average of eight knots an hour when in the light condition; seven knots an hour when in the awash condition, with a minimum endurance of twelve hours at these speeds, using only the gasolene engine, and seven knots an hour when completely submerged, with a minimum endurance of three hours at this speed.

'CONFORMITY WITH CONTRACT.

'3. Said vessel shall be found in all their parts to be strong and well built, and in strict conformity with the contract, plans, and specifications and duly authorised changes therein.'

In reply to the Secretary's suggestion that 'there is no pressing exigency for more, and in view of the large naval expenditures in hand and estimated for,' he does not regard 'further expenditure at this time *essential;*' we respectfully submit that these reasons apply with far greater force to the two battleships and two cruisers that have been provided for in the Naval Bill just reported to the House than it does to the few 'Holland' boats we ask for.

These battleships cannot be built and delivered within the next five years. They are not essential at this time, and they cost enormously. Why, then, should the 'Holland' boats be singled out for sacrifice on the grounds of economy in naval expenditure, when they are the quickest built, the most formidable, and the most economical of all vessels for coast and harbour defence. We think this would be harsh treatment to our new enterprise.

We ask for seven boats because that is the number recommended to be authorised by Admiral Hichborn in his testimony before the House Committee on the 11th instant.

We ask that the law be made mandatory because we have been assured the Secretary would prefer it so and we desire it so.

In conclusion, we have to state that if Congress fails to provide for additional boats at this session, because of its desire to await the completion and test of the *new* 'Hollands' it will practically amount to punishing us for voluntarily giving the Government the very highest development of sub-

marine boats rather than of duplicating the 'Holland' as she stands, admittedly a satisfactory, practical, fighting war vessel.

Very respectfully,
THE HOLLAND SUBMARINE BOAT CO.,
By E. B. FROST,
Secretary.

SENATE.

56th Congress
2nd Session

Document
No. 122.

'HOLLAND' SUBMARINE BOAT.

January 29, 1901.—Referred to the Committee on Naval Affairs and ordered to be printed.

Mr. Stewart presented the following:—
Letter of Admiral Dewey, United States Navy, addressed to Hon. William M. Stewart, dated January 28, 1901, testifying to the great value of the 'Holland' Submarine Boat for Coast and Harbour Defence, and repeating his testimony in favour of said Boat, given before the House Committee on Naval Affairs April 23, 1900.

Senate Chambers,
Washington, D.C.,
January 28, 1901.

Dear Sir,

I hand you herewith in a printed letter addressed to Hon. Eugene Hale, Chairman of the Committee on Naval Affairs, by the Holland Torpedo Boat Company, dated January 25th instant, a copy of an amendment I propose offering to the Naval Appropriation Bill for this year relative to the 'Holland' boats. You will see that no contract is to be made with the Holland Company, until the first one of the six improved 'Hollands' now under construction shall have been tested and tried and accepted as working satisfactorily to the Secretary of the Navy.

I enclose copy of the contract (on page 25 of said letter) and call your attention to the rigid requirements of these new boats.

In view of your testimony before the House Committee last session, which is enclosed herewith, and also in view of the favourable reports upon the 'Holland' by officers of the Navy since she has been in possession of the Department to the present time, copies of which are set out in said letter, and includes the reports of Rear-Admiral Farquhar, Captain Folger, Commander Mason, Commanding Torpedo Station; Commander Wainwright, Superintendent Naval Academy; and Lieutenant Caldwell, commanding the 'Holland,' I respectfully ask you to state if you agree with them as to the great value of the 'Holland' submarine type of boats for harbour and coast defence, and if you entertain the same views with regard to the appropriation for seven additional boats during this session that Admiral Hichborn does, who, in his testimony, also set out in said pamphlet, strongly recommends and urges that the Government shall continue the construction of these boats.

I desire your reply to this for the information of the Senate.

Yours respectfully,

(Signed) WM. M. STEWART.

Admiral George Dewey, U.S.N.,
Washington, D.C.

Office of the Admiral,
Washington, D.C.,
January 28, 1901.

Dear Sir,

I have the honour to acknowledge the receipt of your communication of even date, with enclosures, relative to the 'Holland' submarine boat, and particularly to an amendment which you propose to offer to the pending Naval Appropriation Bill providing for the construction by contract of seven additional boats of this type.

Replying to the first of the questions which you propound, viz., whether or not, in view of the favourable reports made

by Officers of the Navy upon the U.S.S. 'Holland' since she has been in possession of the Government, I agree with those officers as to the great value of this type of boat for harbour and coast defence, I have to state that I do, and that my opinion as to its value has not changed since my testimony before the House Committee on Naval Affairs in April last.

Referring to your second question, asking if I entertain the same views with regard to an appropriation for seven additional submarine boats during this session, as does Rear-Admiral Hichborn, who recommends that the Government shall continue the construction of the 'Holland' boats, I have to state that the Secretary of the Navy having, in a letter to the Chairman of the House Committee on Naval Affairs, under date of the 9th instant, set forth the policy of the Department concerning the construction of additional submarine boats at this time, it would, in my judgment, be unbecoming in me to express a different opinion.

Yours respectfully,
(Signed) GEORGE DEWEY,
Admiral U.S.N.

Hon. William M. Stewart,
United States Senate, Washington, D.C.

PRACTICAL PREVENTION OF WAR.

A NAVAL TRACT.

'In Modern Peace, who controls the sea Wins.'
George Dewey.

To W. R. Hearst, Editor 'New York Journal':—

'In Modern War, who conquers the sea Wins.'

This closing sentence of your editorial of Sunday last on 'The Command of the Ocean,' expresses a truth so well demonstrated by the results of the naval battles of Manila and Santiago as to need little or no comment. But it is

not in war alone that sea supremacy is of vital importance. I would make the sentence read:—

'IN MODERN PEACE, WHO CONTROLS THE SEA WINS.'

Wins what?

All the great nations are striving, to-day as never before, for increase of commerce—not for the commerce of the East merely, but that of the world in general; and side by side with the increase of commerce must be placed the necessity for its protection, for the nation which is lacking in power to protect its commerce upon the seas and in its ports, is not only without hope of commercial advancement, but is almost certain for retrogression. Recent events have made it clear that the country which has the strongest navy is sure to carry off the plums of commerce.

All honour to the journal for its long-continued demand that 'A mighty navy be provided for this, our beloved country. We need a mighty navy, not for offensive purposes, but for the development of commerce and the prevention of war. As is so well shown by Lieutenant-Commander Kimball in his article on 'Insurance of property against war risks,' recently published in the Forum, the establishment and maintenance is the cheapest and best protection against war, and the losses resulting therefrom. If we have a navy equal to that of any other nation, we shall have nothing to fear in the way of attack; for inasmuch as it is possible, as we have seen, for the United States to raise an immense army in a comparatively short time, this country could, with a strong and effective navy, be out of danger of invasion from any power on earth.

Shall we have a navy of this kind?

The present year closes a century which has been essentially one of progress, and it is not to be believed that this country will fail to continue the work so well begun, of building up a navy adequate to our needs. With America's great wealth and resources, we could, without appreciable effort, build and maintain a navy equal to cope with that of any power in the world, and if this be done, we shall not need,

as do the Continental Powers of Europe a large standing army.

I deem it unnecessary to speak here of the character and size of the vessels which this country should build, or the calibre of the guns which should be mounted upon them. These matters may, in my opinion, safely be left to the wisdom of the Congress and the Secretary of the Navy, and his able advisers. But let us have one of the best and most effective navies of the world, let us have the Nicaragua Canal to assist us in making it effective, and we shall see that 'in modern peace, who controls the sea wins' a large share of the commerce of the world, as well as a pre-eminent place among nations.

GEORGE DEWEY.

(Published by permission of the 'N.Y. Journal').

Insurance of Property Against War Risks.

As a general rule, our shrewd business men, our intelligent farmers, and our professional men insure their property which is exposed to fire risks. Now, these men know that all property in the United States is exposed to depreciation and loss from the risks of war, be the property hog products in Chicago, wheat in the wheat belt, reality in New York, or anything else that makes for national wealth. They know too, that the chances of heavy loss from the effects of war are greater than those from fire, and that the cost of insurance against war risks is considerably less than that of insurance against fire. Yet they act—as their prototypes have always acted from the foundation of the Republic—as if these plain facts did not exist, or as if the comprehension of them were lacking.

Why such a curious assumption should be indulged in has never been satisfactorily explained. The reason for allowing ourselves this indulgence, if reason there be, is inconceivable to the mind of the ordinary seafaring man, when it is remembered that we are rather fond of securing the collection of dollars, that we pride ourselves on our hard common sense

and broad views, and that this indulgence has cost us, during the life of the nation, many and many a million of dollars, not to mention many thousands of needlessly expended lives.

When the writer, in his youth, was serving in the curious craft of the day, that possessed the then four prime requisites of an American man-o'-war—inability to sail, to steam, to fight, or to run away,—and when the navy existed simply and solely as an excuse for naval yard appropriations and for employing workmen to vote at elections, he was led into the error of supposing that our neglect of insurance against war risks was due to the fact that we had no business men possessed of business common sense. The hypothesis was, of course, untenable; and the assumption of it cannot be excused even on the plea of the crudeness of the youthful mind. But, when the environment and sources of information in those days are considered, the supposition does not seem entirely unnatural.

On one occasion information was sought from an English sub-lieutenant as to why his country made such large expenditure upon its navy, and was found in the statement, 'O, Parliament wouldn't vote the Service two-pence half-penny, nor would the Government allow it half-crown, if they had their way; but the city men will have it. They've got to have their war insurance from the navy, you know.'

That was clear. It was also clear that the property ashore and afloat belonging to our business men, like that of Englishmen, was exposed to war risks, to the same risks in kind, though perhaps in less degree,—perhaps greater, if war risks are invited by not insuring against them. Therefore, it is not so very surprising that, in the ignorance and intolerance of youth, I attributed our singular indifference to a plain business principle, to lack of mental grasp on the part of our business men.

And, after all, this point of view would seem to be, even now, no more erroneous than the opinion of a very high authority upon our national and business affairs, who, when asked recently why war risks were not insured against in our country, said, 'Because our business men practically control out national expenditures; and they prefer, as we all prefer, to cut down necessary expenses far below the point of true

economy, and then, feeling that we have saved something, to proceed to lavish public money in worse than useless ways.'

Though interesting, this statement, even if true, does not explain anything at all. Moreover, it cannot be accepted as definitely settling the question; since we must, at all hazards, preserve our faith in the acumen of our business men,—a faith that would be rudely shaken if we accepted the foregoing dictum. There is an explanation; there must be one; but what it is will probably always remain an inscrutable mystery to the lay mind. As a matter of fact, the underlying idea of providing a war insurance is slowly forging to the front. The movement is slow, at times even retrograde; but the general result is a progressive one. We are preparing both fixed and mobile defences to protect our property against war losses.

To be sure, we are, after our own peculiar manner, preparing these defences in the most illogical and, consequently, in the most expensive way. The fixed and mobile defences, which should have the closest interrelations,—so close that no fortification should be planned until it had been determined what part of the fence was to be made by the navy, nor any ship designed until a clear idea had been formed as to the nature and extent of the support to be afforded by the army to the mobile defences,—have no relations whatever.

This is one of the natural results of our administration through independent departments and of our allowing each department to act as if it were the whole and only government.

For example, the Navy Department has a little army of its own in the Marine Corps; the Interior Department has one in the Indian Police; and the War Department has one in the Army proper. The Treasury Department has three navies,—the Revenue Marine Navy, the Coast Survey Navy, and the Fish Commission Navy. The War Department has two,—the Engineer Navy and the Quartermaster Navy. The Navy Department has one in the Navy proper. Being a free and independent people, we decide to keep up half a dozen free and independent navies; and since no other country possesses half as many, the first view of this fact would seem

to indicate that we are a very maritime nation. When the character of our navies is considered, however, this view must be considerably modified. Abroad, they are considered a most curious lot; but we like them.

However stupidly and wastefully we may be going about the preparation of our defences, we are surely making progress; and we have already made great improvements in material. Twenty-five years ago the average utility of our war material was twenty-five years behind that of the civilised world; five years ago we were only five years behind; and to-day we are probably not much more behind than that, albeit the arms in the hands of our infantry and cavalry does not admit of quick recharging, and, therefore, was obsolete in design long before we began its manufacture.

It is true that we shall stick to our favourite theory, that the possession of guns makes an army, the possession of ships makes a navy, and the possession of both makes defences,—a theory lacking in basis of fact and common sense. But, since the late pseudo-war with a pitifully weak nation, we are beginning to feel that there may be something in the soldier's trade besides rallying round the flag, and are slowly becoming conscious of the fact that a seaman may have other functions than those which have been properly attributed to him, viz., hitching up his trousers, chewing tobacco, and dancing a hornpipe. We have even discovered that putting a heterogeneous lot of landsmen into naval uniforms does not make officers and seamen of them; though, for political purposes, we prefer to assume that it does.

When Captain Mahan first defined sea-power for us, we naturally paid no attention to him, because the matter discussed had something to do with the sea, and was one which we did not understand and in which we took no interest. We never accept any new ideas upon things connected with war until they have been approved by foreign nations after we have first rejected them through lack of comprehension. The rapidity with which Mahan's teachings were accepted throughout the civilized world was a difficult puzzle to us; and we could not make out why there was so much foreign enthusiasm over some stuff a seaman had written about the sea. But since there was no question about the acceptance of these

teachings abroad, we, after our manner, closed in at the tail-end of the procession, and accepted them too, as far as acknowledging that sea-power was sea-power, and a good thing to have, but not to the extent of inducing us to take any real steps towards securing it.

However, a few ships were built,—very creditable ships they are too, individually—that had absolutely no connection with the strategic necessities of this country; a few torpedo boats were constructed having no relation to each other, to the existing condition of the coast they were to defend, or to anything in the heavens above, or in the earth beneath, or in the waters under the earth; and there were a few sporadic cases of shore fortifications.

No demonstration is needed to show that the most economical way to provide insurance against war losses is, first, to prepare ourselves for war in such a way that a possible enemy would find neither *prestige* nor profit in fighting us, and would, therefore, abstain from entering upon a war with us; and, second, so to prepare our military power that, if a war should come, our losses of property would be minimized.

It is apparent that both these desired results, deterence and the minimising of the losses, would be most nearly secured if we were always ready, with whatever sea-power we possessed, to strike the enemy quickly and to strike him hard, on the deep sea, or at some vulnerable points on his own coast.

It is also apparent that we could not so utilise our sea-power without risking great property losses, unless our own coasts were secured against cruiser-raiding operations, blockades, and bombardments by the enemy in the absence of our fleet upon duty elsewhere.

Last summer's pitiful exhibition of baseless panic along the New England coast advertised to the world the fact that any enterprising enemy of half our sea-power might find both *prestige* and profit in a war with us; for it was made plain that, through the agency of public panic created by the smoke of a couple of his cruisers, he could neutralise the power of our whole fleet by keeping it scattered along our coast-line, and could therefore keep his own fleet practically intact to carry out his own sweet will, while being absolutely free

from any uneasiness in regard to his own coasts or lines of communications.

In a country like ours,—which has just decided by national legislation that a sea officer is worth to it only 85 per cent. of the value of a shore officer,—there is almost no prospect that an economical use of sea-power will ever be attempted; for that would require a fleet constructed upon the lines of a reasonable policy; and we have no policy. Still, the case is not entirely hopeless. A quarter-century ago there was no prospect that our flag would ever fly from the staff of a vessel resembling even remotely a real man-o'-war; yet to-day it is flying aboard several ships that no country need be ashamed of. And so, with the help of a little unreasonable but quite natural optimism, it seems possible that some time in the future we may secure the chief strategic points and wealth-centres of our coasts by shore and torpedo boat defences, and thus be able to utilise as a real war preventive the small fleet we have.

We have already shown some evidences that, in a vague kind of way, we are beginning to grasp the idea that fixed defences to prevent the free entrance to our ports by a hostile force may be economically desirable. But our extreme non-maritimeness (if I may coin a word) prevents us from seeing that the blockade of a port would be almost as serious financially as its capture and ransom; that the use of a battleship to do a torpedo boat's work in the mobile defences is a most expensive manner of procedure.

At present, while we offer a possible enemy an inducement to make war, by showing him how he can neutralise the effect of all our battleships by the use of a cruiser or two, we carefully abstain from preparing to utilise our own torpedo boats within their narrow (but, to us, most important) field of work, to neutralize the operations of his battleships; and this condition will obtain until we provide a real torpedo boat service organized on lines plainly defined by the strategic necessities of our coasts.

As has been stated, we have built a few torpedo boats. We are building a few more, apparently not for service, but for the purpose of giving contracts and practice to our boat-builders; since the boats are of all shapes and sizes, and

the few completed ones are not being used to develop a torpedo boat service or, in fact, for any purpose whatever. But really we have a good excuse. We were very much frightened last summer by three Spanish torpedo craft; but when Spanish lack of enterprise prevented their use against us, and when, moreover, the Spaniards took a couple of them out in daylight, in face of a fire of a strong fleet, to certain destruction, and even then made no attempt to utilise their real power of attack, we were so relieved that our joy took the form of assuring ourselves that we had not been scared at all, that torpedo boats were useless, that we would never use ours again, and that there were no good torpedo boats in the world.

Our normal composure will be gained after a time; and then we shall be in a condition to accept the well-known fact, that three fairly good, fairly well handled torpedo boats can, on a moonless night, before the best battleship in the world, off her blockading station, or put her *hors de combat.* We may even appreciate the fact submarine torpedo boats furnish more insurance against war losses per dollar expended in insurance than any other form of defence at present known.

This proposition might be highly absurd, if it included any idea that we should take the lead in developing a new kind of war material; but it does not. France is already providing herself with submarine boats; and it would seem possible that we might at once copy her instead of waiting till all the rest of the world had adopted the idea, especially as we have already gone through our usual preliminary process of rejecting this war device,—a device developed in our own country by private enterprise, and one of the greatest value to a country situated like our own in regard to the necessities of coast defence.

Fifteen years ago a private citizen of this country led the world in successful submarine boat designing and experience. It was clear that for a weak naval power like the United States, practical submarine boats would be of the greatest economic use; since an inexpensive boat, with a small crew, could move up to a battleship, by day or by night, in face of her fire and searchlights, and could force her to leave her blockading station or could sink her. In other

words, in the presence of defensive submarine torpedo boats, blockades could not exist, nor could bombardments be attempted. It was also clear that the development of submarine torpedo boats presented fewer difficulties than did that of surface torpedo boats. It was clear, too, that we had it in our power to take advantage of the great change in naval methods that must follow the appearance of submarine boats,—to lead the world, in fact, for our economical advantage, instead of following, and paying the cost of our slowness.

The submarine boat idea was fumbled with a bit, and then practically dropped, just as the magazine-gun idea a third of a century ago. In the case of the gun we proved its utility in the War of the Rebellion; and then, instead of developing it, we dropped it altogether, and delightfully adopted an obsolete single-loader.

In the case of the submarine boat, as I have said, we dallied with the idea, brought into play our ever-effective way of how not to do it, by exercising the see-saw between the legislative and executive branches of the Government, and then practically dropped the matter. Meanwhile, France, appreciating what submarines meant to her, and failing to get good results along her experimental line of development, seized on the general principles of the American design, declared in her leading technical journal that it was the first submarine boat constructed on rational data, and applied its principles, so far as they were publicly known, to the submarine flotilla she was then constructing.

The more valuable and practicable features of the American design are still held in this country; and it will be amusing to observe whether we utilise them or not. It will be interesting to note whether we accept the device that can most economically strengthen our weak defences and give us most war insurance at least cost, or whether, being still joined to our idols of indifference, we let it alone.

W. W. KIMBALL.

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SENATE.

56th Congress. 2nd Session.

Document No. 71.

SUBMARINE BOAT 'HOLLAND.'

LETTER

FROM

THE SECRETARY OF THE NAVY,

Transmitting,

In compliance with Resolution of the Senate of December 10, 1900, Copies of all Reports in the possession of the Navy Department and Extracts from Reports on File in the Bureau of Navigation, concerning the submarine boat 'Holland.'

January 3, 1900. Ordered to be printed.

Navy Department,
Washington, December 18, 1900.

Sir,

In compliance with the resolution of the United States Senate of December 10, 1900, I enclose herewith copies of all reports in the possession of the Department and extracts from reports on file in the Bureau of Navigation. These contain all remarks concerning the submarine boat 'Holland' made in reports to the Department since her purchase by the Navy Department.

The Bureau of Navigation, in forwarding to the Department copies of such parts of the papers on file in that Bureau as contain remarks of officers mentioned in the resolution in regard to the 'Holland' boat, states that these remarks are in some cases included in reports in regard to other matters, and that such reports are not given in full. The Bureau suggests that the Department should recommend to the Senate that it is not desirable for the public interests that the

reports containing information other than that concerning the performances of the 'Holland' should be made public.

Very respectfully,

J. D. LONG,

Secretary.

The President Pro Tempore, United States Senate.
Washington, D.C.

229 A.

(Extracts from the records of the Bureau of Navigation concerning the U.S.T.B. 'Holland.')

From Report of Commanding Officer of the U.S.S. 'Scorpion':

The moral effect of an anticipated attack from the 'Holland' submarine boat was great, particularly as the ship was so stationed as to preclude the possibility of being continually under way at a speed sufficient to have an opportunity of escaping such attack.

From Report of the Commanding Officer of the U.S.S. 'Kearsage':

It is clear that the 'Holland' type will play a very serious part in future naval warfare. There is no doubt whatever that the vessel at Newport can approach a turret ship unseen, either by night or day. Her only danger is she may be run over herself by picket or large vessel.

From Report of Commander-in-Chief, North Atlantic Station:

The 'Holland' impressed everyone with the idea that under ordinary circumstances she could always get in a

torpedo, either day or night, without being discovered. Unfortunately, in her attack upon the 'Kearsage,' the second night, she did not reach there until several torpedo boats did, so that so strict a look-out was probably not being kept as would otherwise have been.

The second night's operations consisted in an attack upon the outside, or Red, squadron, by five torpedo-boats and the 'Holland.' As a rule, the torpedo-boats were successful, although this would scarcely have been the case with an efficient picket-boat service.

'A.'

Naval Torpedo Station,
Newport, R.I., June 28th, 1900.

Sir,

Referring to the Bureau's letters Nos. 4362, April 30, and 4746, May 5th, 1900:—

1. I have to inform the Bureau that the submarine boat 'Holland' arrived at this station on Sunday, June 24, 1900, in tow of the tug 'Osceola' and in charge of Mr. Cable, of the Holland Company, together with three assistants.

2. As the boat was not in running condition I have not taken complete charge of her as yet, although the station watchmen look out for her during the absence of the Company's men.

3. On the trip up a section was burned out of the armature of the main motor. This motor has now been dismantled by the Company's men and an examination has been made, and it is considered that the services of an expert electrician are required. Mr. Cable, the Company's representative, who is in charge, suggests that an expert from the works of the Electro-Dynamic Company, of Philadelphia, be sent on here to repair damages, as it is impossible to remove the motor or the armature from the boat; and also, as this company furnished the machines, it is considered necessary that their expert should do the work. It will take four or five days to do this work.

4. I have to request information from the Bureau as to

whether this work is to be undertaken and paid for by the Government, in which case the appropriation under which the work is to be done is requested, or whether it is obligatory on the Holland Company to turn her over at this station in good condition.

5. I have also to request information in regard to the officers and crew for this boat. Several officers have volunteered for the command, but have not been allowed to take the duty on account of the exigencies of the service. Lieutenant Caldwell, a member of the class under instruction, has been placed in temporary charge of the boat, but at the end of the course at this station he will resume his duties on the staff of the Admiral of the Navy and will not be available. In regard to the crew, there are at present no sufficiently reliable men available for the boat, and as the torpedo-boats are so very short-handed it would be almost impossible to spare them if any of them were considered to have sufficient qualifications for the work.

Very respectfully,

N. E. MASON.

Commander U.S.N. Inspector of Ordnance, in Charge.

Bureau of Ordnance,

Navy Department.

(First indorsement)

Navy Department,
Bureau of Ordnance,
Washington, D.C., June 29, 1900.

1. Respectfully referred to the Bureau of Navigation, with reference to the queries contained in paragraph 5 of the within letter.

2. As seven other submarine boats are authorized, it would seem to be essential that a certain number of men and at least one officer to begin with should be trained as to their use, and the Bureau respectfully recommends that an officer be detailed for service in connection with the 'Holland,' and that a crew be assigned to her which, according to the Hol-

land Company, should consist of a commanding officer and the following men: 1 electrician, 2 machinists, 2 seamen gunners.

3. By the terms of its contract the Company is obliged to instruct the Government in the use of the 'Holland,' and as the Company's employees are now at Newport it would seem to be an appropriate time to make use of their services.

4. The Bureau has ordered the necessary repairs made to the 'Holland.'

5. The Bureau understands that Junior Lieutenant Frank P. Baldwin, U.S.N., has applied for command of the 'Holland.'

CHARLES O'NEIL,
Chief of Bureau of Ordnance.

(Second indorsement)

Department of the Navy, Bureau of Navigation,
Washington, D.C., June 30, 1900.

Respectfully returned to inspector of ordnance, Naval Torpedo Station, Newport, R.I., (through Bureau of Equipment).

1. Referring to second paragraph of first indorsement, there are no electricians, machinists, or seamen gunners available for duty other than those attached to the torpedo station and torpedo-boats. The Bureau suggests that the inspector of ordnance in charge of torpedo station assign such persons as he may consider competent from the torpedo boat flotilla.

WM. S. COWLES,
Acting Chief of Bureau.

(Third indorsement)

Naval Torpedo Station,
Newport, R.I.,
July 6, 1900.

Noted, and respectfully returned to Bureau of Ordnance.

1. As we are now running six torpedo boats with men enough to make up the complement of four, it will cripple the

station somewhat to furnish a crew for the 'Holland.' However, it will be done, but a skilled electrician can not be obtained at this station.

2. In regard to the officers, Lieutenant Caldwell has been temporarily detailed in charge of the boat, and will possibly be able to remain with her until the latter part of September, when he will have to resume his duties on the staff of the Admiral.

N. E. MASON,
Commander U.S. Navy, Inspector of Ordnance, in Charge.

'B.'

Navy Torpedo Station,
Newport, R.I., July 2, 1900.

Sir,

1. The bottom of the submarine boat 'Holland' is apparently badly fouled, and there are signs of pitting along and just below the water line.

2. This boat was last docked and painted on November 29, 1899, and should be docked again as soon as possible.

3. As there is some doubt in my mind as to whether the torpedo station ways will safely haul this boat out on account of the greater part of the weight coming on a small portion of the ways at one time, I have to request permission to have her docked and cleaned at Providence or Bristol just as soon as the present repairs to the motor are completed.

Very respectfully,
N. E. MASON.
Commander, U.S.N., Inspector of Ordnance, in Charge,
Navy Department.

Bureau of Construction and Repair,
(Through Bureau of Ordnance).

'C.'

(Extract from Annual Report of Naval Torpedo Station, September 1, 1900.)

Submarine boat 'Holland':—The 'Holland' submarine torpedo boat arrived at this station on June 24, 1900, in charge of a crew furnished by the Holland Company. Lieutenant Harry H Caldwell, a member of the class under instruction, was detailed to take charge of her with a navy crew, and since that date has been engaged in training and instructing this crew under the supervision of the crew furnished by the Holland Company. Lieutenant Caldwell volunteered for this duty and performed it very efficiently in addition to his work with the class under instruction, and to him is due all the credit for the present efficiency of the 'Holland.' Up to the present date the boat has made ten runs entirely under the control of the navy crew.

A number of minor repairs to the machinery have been made from time to time. The navy crew is fast completing its instruction, and in all probability it will be possible to dispense with the 'Holland' experts by September 1. This boat requires constant attention, and should be kept in commission all the time and not hauled out.

'D.'

Report of Commander N. E. Mason, U.S.N., Commanding Naval Torpedo Station.

Naval Torpedo Station,
Newport, R.I., October 1st, 1900.

Sir,

Referring to Bureau's letter No. 4362, of April 30, 1900, giving directions concerning the care and test of the submarine torpedo-boat 'Holland.'

1. I have to forward herewith, approved, copy of a report of Lieutenant Caldwell, U.S.N., commanding the 'Holland' on operations and experiments with that boat since her arrival at this station.

2. In my opinion the 'Holland' has been a grand success so far, and for some time the naval crew have had entire charge of her, under command of Lieutenant Caldwell, running and working her both night and day, without the presence of any of the 'Holland' experts.

3. Having made several dives in the boat myself with the naval crew alone, I am of the opinion that they are competent in every way to manœuvre and manipulate the boat successfully.

4. During the late combined manœuvres of the fleet, shore defences, and the torpedo flotilla the 'Holland' made a successful attack on the fleet at night by herself, without convoy, at a distance of 7 miles out from the mouth of the harbour, and with the naval crew alone in her.

5. I have to call especial attention to the recommendation of Lieutenant Caldwell that this boat be not laid up for the winter but be kept in commission all the time. If torpedo boats will deteriorate, as they do while hauled out on the ways for short periods, surely a boat like the 'Holland,' filled with various and delicate mechanisms, will be in better condition when kept running constantly.

6. As the temperature of the water, and also the weather, during the winter in Newport is not particularly favourable for submarine work, I have to recommend that this boat be sent south for a further experiment and practice, and also for use as a school of instruction for the officers and crews of the other boats contracted for. Lieutenant Caldwell hopes to obtain permission from the Admiral to remain in command of the 'Holland,' and carry on this work, provided it is agreeable to the Department. I consider him well qualified for the duty, and recommend that he be given this command.

7. If either of the gun-boats 'Sandoval' or 'Alvarado' or a small tug are available, I have to suggest that one of them be commissioned, under the command of Lieutenant Caldwell, with a detail of men, for submarine-boat work, the gun-boat or tug to be the convoy and the living place for the crew, all of whom are for submarine work, a sufficient number in excess being sent to handle the convoy while manœuvring and diving. In this way constant drill and practice will be kept up, and if the boat is sent to some place like the Naval Academy for the winter months a great deal of instruction could be given to the officers of the service in a boat which is bound to be one of the future types.

8. A complete description of the 'Holland,' together with as full instructions for her care and management, etc., as is

possible, will be prepared by Lieutenant Caldwell at an early date and forwarded to the Bureau.

Respectfully,
N. E. MASON,
Commander U.S.N., Inspector of Ordnance, in Charge.

Bureau of Ordnance,
Navy Department,
Washington, D.C.

(First indorsement)
Department of the Navy,
Bureau of Ordnance.
Washington, D.C., October 5th, 1900.

1. Respectfully referred to the Department via Bureau of Navigation.

2. Attention is invited to the recommendations contained in paragraphs 5, 6, and 7, of the within letter of the inspector of ordnance in charge of the torpedo station, in which it is recommended that the 'Holland' be sent south for further experiment and practice, suggesting Annapolis as a suitable place.

3. Attention is invited to paragraph 10 in the report of Lieutenant H. H. Caldwell, U.S.N., who has had charge of the 'Holland' during the summer, and who is of the opinion that she should not be laid up, as there is danger of her deteriorating under such conditions.

4. In view of the fact that several submarine boats are under contract and that it will be necessary to instruct both officers and enlisted men as to their care and use, the Bureau is of the opinion that it would be advisable to make use of the 'Holland' for the purpose, and as she can not be advantageously used during the winter months at a northern port, Annapolis would seem to be a suitable place.

5. The Bureau further recommends that the 'Holland' be placed in commission and put under the command of Lieutenant Caldwell, if the same meets with the Department's ap-

proval, and that a suitable tender be assigned to carry her stores and to provide living quarters for her personnel.

CHARLES O'NEIL,
Chief of Bureau of Ordnance.

(Second indorsement)
Department of the Navy, Bureau of Navigation,
Washington, D.C., October 8, 1900.

Respectfully returned to the Bureau of Ordnance.

The different recommendations of the Bureau of Ordnance have been carried out by orders issued by the Department on October 6.

A. S. CROWNINSHIELD,
Chief of Bureau.

Report of Lieutenant Caldwell, Commanding the 'Holland.'

Naval Torpedo Station,
Newport, R.I., September 27, 1900.

Sir,

1. I have the honour to submit the following report of the operations of the 'Holland' to date.

2. The 'Holland' arrived at this station on June 24, 1900, in charge of Mr. Frank T. Cable and the crew of experts provided by the Holland Company in accordance with paragraph 3 of the contract under which the boat was purchased. I was assigned to duty with the boat, and by July 7 Acting Gunner Owen Hill and five petty officers and seamen gunners had been selected from the numerous volunteers.

3. Shortly after the arrival of the boat two bars of the armature of the main motor burned out at different times, necessitating sending for an electrician from the builders in Philadelphia each time to put in new bars and rewind the bindings. This was due to moisture on the armature making short circuit between bars. No further trouble has been had

from this, and care has been taken to run the motor for a few minutes every day to warm it up, and prevent the gathering of moisture. The 'Holland' was accidentally sunk at her moorings about two years ago, and this same motor was soaked in salt water overnight, and after that much trouble was had from the same cause, but none from about eighteen months ago to this time. This armature is not removable from the boat as it should be, and it is very difficult to get the proper tension for rewinding the bindings in the contracted space it now occupies.

4. July 7 to 17 was spent by the naval crew learning the mechanism of the boat under the instruction of the 'Holland' experts. On the 17th, 19th, and 20th made surface runs, using both gas engine and motor, and shifting from one to the other. On July 28 a submerged run was made, the boat handled by the 'Holland' experts.

5. On July 31 the boat was hauled out on the ways at Crowley's shipyard, cleaned, and painted. Outside manhole plates were taken off midship and after ballast tanks, and considerable rusting was found in them, especially the after one, in which a large quantity of cork had been placed to reduce its volume for water. These tanks are not accessible for cleaning because the frames are close together, and have solid bulkheads across, with only small holes in them. In new constructions all ballast tanks should be made accessible for cleaning in every part by manholes with plates inside the boat.

6. On August 6, 7, 11, and 15 made submerged runs, gradually working in the naval crew and leaving out the 'Holland' experts. Also exercised putting torpedo into boat and firing it.

7. On August 17 a cast-iron disk of the friction clutch connecting the gas engine to the motor broke. A new one was received from the makers in Philadelphia and put in on the 28th. It was strengthened by shrinking on a wrought-iron band, and no further trouble is expected with this clutch.

8. At about this time much difficulty was experienced in the supply of gasoline to the gas engine, much water being carried over with it. It was the practice of Mr. Cable to admit salt water to the gasoline tank to assist in getting the

boat into diving trim. The gasoline was pumped to the engine through a float that was designed to rise and fall with the gasoline and remain in it, but it is supposed that it became leaky or sank far enough to take some of the water with the gasoline. The defect had been remedied by ceasing to put water in the gasoline tank, and I have never found it necessary to do so, the supply of gasoline being kept well up. An auxiliary feed pipe has been fitted, sticking down into the tank from the top, and this can be used in case it ever becomes necessary to use water in the tank. This tank has only one manhole, opening into the boat, and I am told that it is almost impossible with repeated washing to get the gasoline fumes out of the tank so that a man can go in it with safety. It seems to me very necessary that there be two manholes in the tanks in the new boats in order to get a good current of air through it when it is opened for inspection and cleaning.

9. On August 30 and 31, September 5, 6, 8, and 11, practiced with submerged runs, the naval crew doing all the work.

10. The naval crew is now sufficiently well trained to dispense with the services of the 'Holland' experts, but there is still much for us to learn about the boat. She is in excellent condition, and has had no breakdown since the friction clutch. There have been many minor accidents, but, I think, fewer than on the ordinary torpedo boat. I would urge that she be kept going, for I doubt seriously if she would maintain her efficiency without a crew to keep her delicate mechanism in order.

11. The enlisted men in such a boat must be of the highest intelligence, steady of nerve, quick of resource, and implicitly obedient. The present crew fulfils these requirements. The officer in the turret cannot see what his men are doing and must be able to thoroughly rely on them, as the safety of the boat depends on the individual action of any one. It seems only fair that these men should receive extra compensation.

12. All the mechanism should be tested every day if possible. The main motor especially should be run every day. All gasoline connections should be examined every day. Each cell of the storage battery should be tested once

a month for E.M.F. and gravity of acid, and acid should be added whenever necessary. The pump should be put on every ballast tank every day, and the Kingston valves should be worked at least twice a week. The boat should be ventilated as much as possible, but great care should be taken to protect the motors from moisture.

13. In concluding this report, I desire to call your attention to the ability, patience, and courtesy shown by Mr. Cable and his assistants in instructing the naval crew in the handling of the 'Holland.'

Very respectfully,
H. H. CALDWELL,
Lieutenant U.S.N.

Inspector of Ordnance in Charge,
Naval Torpedo Station, Newport, R.I.

'E.'
(Telegram)
Bureau of Ordnance, Navy Department,
October 13, 1900.

Naval Torpedo Station,
Newport, R.I.

Send 'Leyden' to convoy 'Holland' to Delaware City. Will be met there from Annapolis. Notify Naval Academy probable date of arrival at Delaware City.

O'NEIL.

'F.'
(Telegram)
Naval Torpedo Station,
Newport, R.I., October 13th, 1900.

Navy Department,
Washington, D.C.

If 'Potomac' not coming, 'Leyden' can convoy 'Holland' as far as Delaware City. Request small gunboat from Annapolis meet them there to take outfit and baggage back through

canal and convoy to Annapolis. Superintendent Naval Academy agrees if Department approves. Probably ready Tuesday.

MASON.

(Through Bureau of Ordnance.)

'G.'

Naval Torpedo Station,
Newport, R.I., October 16th, 1900.

Sir,

Referring to Bureau's telegram of October 13, 1900, concerning sending the 'Leyden' to convoy the 'Holland' to Delaware City.

1. I have to inform the Bureau that the 'Leyden,' Lieutenant E. E. Capehart, U.S.N., commanding, with the 'Holland' in tow, Lieutenant H. H. Caldwell, U.S.N., commanding, left this station for Delaware City, Del., via the Sound, New York Harbour, Sandy Hook, and Delaware Bay, at 2 p.m. this day.

2. If the weather is pleasant they expect to reach Delaware City Thursday evening, October 18. The Superintendent of the Naval Academy has been so informed.

3. As soon as the convoy from the Naval Academy has received the outfit and stores of the 'Holland' from the 'Leyden' her commanding officer has been directed to return to this station and resume his duties.

4. This report has also been made to the Navy Department.

Respectfully,

N. E. MASON,
Commander, U.S.N., Commanding.

Bureau of Ordnance,
Navy Department, Washington, D.C.

'H.'

Department of the Navy,
Bureau of Ordnance,
Washington, D.C., November 9, 1900.

Sir,

1. As a matter of general interest, the Bureau desires to know whether or not there was any truth in the recent newspaper reports of a gasoline explosion aboard the 'Holland,' and if such an explosion really occurred, it is requested that a full statement of the circumstances may be supplied.

Respectfully,
THEO. C. FENTON,
Acting Chief of Bureau of Ordnance.

Commanding Officer U.S.S. 'Holland,'
Annapolis, Md.,
(Through Superintendent Naval Academy.)

'I.'

U.S.S. 'Holland.'
Naval Academy, Annapolis, Md., November 10, 1900.

Sir,

1. Replying to the letter of the Bureau of Ordnance No. 10678, of the 9th instant, I have the honour to state that the newspaper reports of a gasoline explosion on board the 'Holland' are false.

2. What probably gave rise to the above-mentioned reports is the fact that a small quantity of gasoline which had been pumped overboard from the 'Holland' was intentionally ignited, causing a small blaze on the surface of the water, but no damage.

3. The newspaper report that the 'Holland' dived about and under the French men-of-war 'Cecille' and 'Suchet during their recent visit to Annapolis is equally false.

Very respectfully,
H. H. CALDWELL,
Lieutenant U.S.N., Commanding.

The Secretary of the Navy,
Navy Department, Washington, D.C.

'J.'

U.S.S. 'Holland,' U.S. Naval Academy,
Annapolis, Md., November 12, 1900.

Sir,

1. I have the honour to report that one or more armature bars of the main motor of the 'Holland' burned out during a run this afternoon, disabling the boat until repaired.

2. This accident has occurred about four times during the history of the boat, and I am unable to assign any cause for it.

3. I request that I may be authorized to write to the makers of this armature, the Electro-Dynamic Company, of Philadelphia, for one of their experts to put in new bars and insulation and rebind the armature. This course was followed when a similar accident occurred at Newport this summer. A requisition for this labour and repairs is forwarded to the Department to-day.

Very respectfully,
H. H. CALDWELL,
Lieutenant U.S.N., Commanding.

The Secretary of the Navy,
Navy Department, Washington, D.C.

'K.'

Department of the Navy, Bureau of Ordnance,
Washington, D.C., November 14, 1900.

Sir,

1. The Bureau has to inform you that since the 'Holland' has been received by the Government some of the armature bars of her main motor have been burnt out, in two instances compelling the employment of an expert from the Electro-Dynamic Company of Philadelphia.

2. The commanding officer of the 'Holland' states that he is unable to assign any cause for these accidents.

3. In view of the fact that there are other boats of the type now building, the Bureau requests that you will consider this question, and see what can be done towards reducing the danger from burnt-out armatures.

4. Did you ever have this trouble when the boat was in your hands?

5. The Bureau will be very glad to hear from you in regard to the matter at an early date, and will try to furnish any further information that you may desire.

Respectfully,

CHARLES O'NEIL,
Chief of Bureau of Ordnance.

Holland Torpedo Boat Co.
No. 38, Corcoran Building, Washington, D.C.

'L.'
U.S.S. 'Holland,'
Naval Academy, Annapolis, Md., November 16, 1900.

Sir,

1. I have the honour to acknowledge the receipt of the letters of the Bureau of Ordnance, No. 11695, of the 14th instant, referring to the burning out of armature bars in the main motor of the 'Holland.'

2. In my opinion, these accidents are due to the faulty design of the armature, the bare copper bars being inserted in slots of the core, with only a narrow space in which the insulating material, 'micanite,' is inserted. When moisture makes its way into the insulating material, it forms a short circuit and fuses the copper of the bars, disabling the motor.

3. In the 'Holland' every possible precaution is taken to keep moisture out of the motor, but it seems impossible to prevent a recurrence of the accident at intervals.

4. I am informed that a different design of armature is adopted for the new boats, in which the bars are baked several times in insulating varnish and completely wrapped with an insulating material, and it is hoped that there will be no trouble with them.

Very respectfully,

H. H. CALDWELL,
Lieutenant U.S.N., Commanding.

The Secretary of the Navy,
Navy Department, Washington, D.C.

'M.'

The Holland Torpedo Boat Company,
New York, November 17, 1900.

Sir,

Your letter of November 14, No. 11695, received.

In reply we would say that we submitted your letter to Mr. Cable, the former captain of the boat and the one person familiar with the electrical equipment, and he gives the following answers to your questions:—

1. The cause of the burning out of armature bars on main motor of the 'Holland' is partly due to the following: The armature is what is termed a bar-wound type; that is to say, the winding is composed of copper bars laid in slots and insulated from the iron by mica strips. These strips are placed so that a joint is made at the top of the bar near the surface of the iron core. Condensation forms in this joint and connects the bar with the core. In this condition, when a ground occurs at any other point in the service, the current passes from the copper bar of the winding to the core, forming an arc which carbonizes the insulation and burns out the bar.

As long as the rest of the service is free from grounds this cannot occur. We had this trouble on one occasion before the 'Holland' made her first run, but the cause was due to the fact that the man in charge left the motor uncovered and the water dripped from the hull, saturating the armature winding.

2. In the boats now building this trouble is entirely eliminated by making the insulation of each bar in several layers so that no joint occurs to admit moisture.

3. At the time of the building of this motor the winding of the armature was the best then known. We are informed by Mr. Cable that very marked improvements have been made in the manner of insulating the windings, and this improved method is to be used in the new boats.

4. Appreciating the interest which you have taken in the success of the 'Holland,' we desire to offer to your Bureau to have a new armature built at our expense, with the same insulation of each bar, in several layers, as will be used in the new boats, and when that is finished and delivered to you we

will also have the armature now in the boat re-wound and delivered, so that you will always have a spare armature.

If this is satisfactory to you, please notify us and the order will be placed at once with the Electro-Dynamic Company of Philadelphia.

Very respectfully,
HOLLAND TORPEDO BOAT COMPANY,
ELIHU B. FROST, Secretary.

Rear-Admiral Charles O'Neil, U.S.N.,
Chief of Bureau of Ordnance,
Navy Department, Washington, D.C.

'N.'

U.S.S. 'Holland,'
Naval Academy, Annapolis, Md., November 17, 1900.

Sir,

I have the honour to report that the repairs to the armature of the main motor of the 'Holland' were completed to-day.

Very respectfully,
H. H. CALDWELL,
Lieutenant U.S.N., Commanding.

The Secretary of the Navy,
Navy Department, Washington, D.C.

'O.'

Department of the Navy, Bureau of Ordnance,
Washington, D.C., November 19, 1900.

Sir,

1. The Bureau is in receipt of a letter from the commanding officer of the U.S.S. 'Holland,' relative to the burning out of armature bars in the main motor of that vessel, which reads in part as follows:—

In my opinion these accidents are due to faulty design of the armature, the bare copper bars being inserted in slots of the core, with only a narrow space in which the insulating material, 'micanite,' is inserted. When moisture makes its

way into the insulating material it forms a short circuit and fuses the copper of the bars, disabling the motor.

In the 'Holland' every possible precaution is taken to keep moisture out of the motor, but it seems impossible to prevent a recurrence of the accident at intervals.

I am informed that a different design of armature is adopted for the new boats, in which the bars are baked several times in insulating varnish and completely wrapped with the insulating material, and it is hoped that there will be no trouble with them.

2. In this connection the Bureau desires to state that this burning out of the main-motor armature has occurred four times since the 'Holland' has been in Government hands, and that each time this Bureau has had the repairs made, the first three times because the boat was in the hands of the Bureau, at the torpedo station, for experimental purposes, and the last time at the Naval Academy, in order that the boat might be put in condition pending the settlement of the question of cognizance herein raised.

3. The Bureau now feels it its duty, however, since other boats of the kind are contracted for, and as the 'Holland' has left the torpedo station, to request the Department to determine the degree to which each of the bureaus is responsible for vessels of this type. Heretofore this Bureau has controlled the vessel in her entirety, but it is thought that this is not in accordance with the present system, and the Bureau therefore requests the Department to inform it as to its degree of responsibility and similar vessels.

4. Pending further instructions from the Department, this Bureau will continue to keep the 'Holland' in the most efficient condition possible.

Respectfully,

CHARLES O'NEIL,
Chief of Bureau of Ordnance.

The Secretary of the Navy.

'P.'

Department of the Navy,
Bureau of Ordnance,
Washington, D.C., November 20, 1900.

Sirs,

Replying to your letter of November 17, 1900, relative to the burning out of the main-motor armature of the 'Holland.'

1. The Bureau accepts, with thanks, your offer to furnish a new armature for that vessel and to rewind the present one.

2. If you will kindly forward the new armature to the boat, at the Naval Academy, Annapolis, Md., the old one will be sent to such point as you may designate, upon its receipt.

Respectfully,

CHARLES O'NEIL,
Chief of Bureau of Ordnance.

Holland Torpedo Boat Company,
New York, N.Y.

PART VI

THE THEORY OF THE SUBMARINE BOAT.

HAVING discussed the history of the submarine boat from the earliest times to the present, we must now enter on the more technical side of the 'problem' of submarine navigation. We know that navigation beneath the surface is at least a *fait accompli*, and that all the leading Powers are the possessors of one or more of the new factor in naval warfare, the submarine or submersible boat, but we have not studied the means by which this result has been attained. As we have seen, the submarine boat is not the evolution of a day, nor the child of some fertile modern brain, but it is the apple of success on the topmost branch of the tall tree of failure, which has taken centuries to climb; it has been the loadstar of many inventors, and in some cases has proved their fate, and yet with all this the submarine boat as we know it to-day can be placed to the single credit of none; it is but an evolution of time. Let me try and define this object which has been so much sought after:

Definition of the Ideal Submarine'

'A vessel of special type, the shape to be determined, but with no speciality of form essential, capable of navigating, not only on the surface as an ordinary ship, but also beneath the surface of the sea and continuing its course in a direct line for the object it is desired to reach, whilst retaining stability in every sense and being under the complete control of its commander; and besides conforming with these conditions it must possess the maximum of speed, safety, offensive power, and habitability, a trustworthy means of propulsion and a complete independence of all exterior help while in action.'

With this definition before us it is a simple matter to divide up the various problems of submarine navigation into sections. The first thing to be discussed is very obvious when one considers the subject, *i.e.*, the submarine boat. This is the power of 'immersion' and 'emersion,' which can be conveniently placed under the heading 'submersion.'

I. Submersion.

Definition of 'Submersion'

The justification of the term 'submarine' as applied to a vessel, is that vessel's capability of descending beneath the surface of the water and of rising again at the will of those controlling it. It is these powers of sinking and rising which constitute the main difference between the submarine and the surface boat; this is an obvious platitude, but to perceive clearly the trend of my reasoning, it is as well to leave out nothing on the score of being common knowledge. Simplicity is the key to comprehension and as such is essential.

Now if the desire is merely to sink to the bottom, no difficulties present themselves,—Day, of Yarmouth, carried out the experiment with pronounced success. But if, on the other hand, it is desired to stop the vessel concerned, in its downward course, at a given depth, we find ourselves face to face with a very complex problem,—a problem which even all the immense powers resultant on the advanced scientific and mechanical knowledge of to-day have failed to solve in a satisfactory manner. You will say, 'Oh, yes, but what of 'Gustave Zédé' the 'Narval' and 'Holland!'—have they not been successful?' Quite so! they have been successful,—but so was the 'Warrior' of 1860, and yet who would compare that old vessel,—worthy yesterday, a hulk to-day:—with the mighty 16,350 ton battleship 'King Edward VII?' In the same way, what submarine ship is there to-day extant that can approach the definition of a perfect submarine as quoted above?

The question of submersion is capable of being discussed from many points of the view,—the elucidation of the problem does not hinge on any one principle of deduction or method of mathematical calculation. From the knowledge acquired

by recent experiments and a careful study of the laws of submersion a solution should not be difficult to arrive at.

Three Types of Buoyancy

It must first be clearly understood,—indeed it is an axiom,—that the submarine boat controverts no law of nature. The whole question hangs on the relative buoyancy or flotability of a floating body to the water sustaining it. There are three distinct divisions into which we can divide this buoyancy,—*i.e.*, negative buoyancy, positive buoyancy and flotability nil.

Without entering into the abstruse science of Hydromechanics it would be well to define shortly the meaning of buoyancy and its reference to immersed bodies.

It is a well-known fact, that a ship floating freely and at rest in still water displaces a volume of water equal in weight to her own weight. The circumstances of the water in which she floats are in fact the same whether the cavity made in the water by the ship is filled by the ship or by a volume of water having the same weight as the ship. When the ship occupies

CCXVI.-CCXVIII.

the cavity the whole of her weight may be supposed to be concentrated at her centre of gravity G and to act vertically downwards. (Fig. CCXVI.)

Displacement

When the cavity is filled with water, its weight, called in relation to the ship the 'displacement,' and in this case corresponding to a submarine boat of flotability nil (Fig. CCXVIII.) may be supposed to be concentrated at B, which is the 'centre of gravity' of the displaced water. This centre of gravity is usually known as the 'centre of buoyancy,' for on this point the upward pressure of the circumambient fluid is equal to the downward pressure of the vessel's weight at G. From this we get back to the old, old principle of Archimedes:—'When a solid body is completely immersed in a homogeneous

Centre of Buoyancy

liquid the pressure of the surrounding water is equal to the weight of the amount of water displaced by that body.'

From this it will be seen that any body placed in water with a total weight slightly less than the amount of water it displaces, will remain on the surface,—*i.e.*, will be possessed of buoyancy. This buoyancy is what I have termed positive buoyancy.

A. Positive Buoyancy.

Definition of Positive Buoyancy

The list of vessels possessed of positive buoyancy includes about 98 per cent. of the submarine boats that have been discussed in the historical part of this book. The main feature of these vessels is that they will remain on the surface unless forced beneath it by mechanical means. If water is introduced into the hull to produce this submersion, the vessel adopting this procedure passes from the class of 'positive buoyancy' to that of flotability nil, since she would then become of the same weight as the water she displaced.

Hence all submarines placed in this category must look to mechanical means for remaining submerged. Let us now see what these mechanical means are.

Two Methods of Submersion

Only two methods of any importance need be noticed in connection with 'forced' submersion, namely by means of inclined planes or rudders and by vertical propellers. Of these two methods we will discuss the last first.

Submersion by Vertical Propellers

A goodly number of boats have used this means of submersion and one of the first real navigable submarines, namely Bushnell's was, it will be remembered, credited with being fitted with a sort of large awl or propeller for driving the vessel beneath the surface. It is not until we reach the first

Tuck

invention of Prof. Tuck in 1884 that any serious step was taken in this matter. In his boat Prof. Tuck placed the propeller directly beneath the centre of the hull so that, all weights being evenly distributed, the downward pull would be exerted in a perfectly vertical sense, and the vessel would submerge on an even keel. This system was also followed

Argles

by A. H. Argles in 1901.

The alternative method of submerging by means of vertical

propellers is in placing these at the sides or extremities in recessed ports, sponsons or channels. The ways of doing this and positions chosen are many and varied. Nordenfelt placed his submersion screws firstly at the sides, secondly, in his Turkish vessels, on the top of the hull at the extremities, and thirdly in recesses in the hull, one at either end. Hovgaard prefers to place the two screws of his vessel in wells, one on either side of the ship, whilst Waddington and Rutley considered channels in direct communication with the ambient sea the most suitable position for their submersion propellers.

Nordenfelt

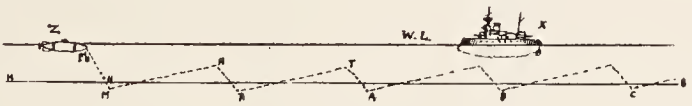
Hovgaard

Waddington

Rutley

Now although the positions were different, the principle on which all these screws worked was very similar. The idea was to rotate them until the required depth was attained and then either by hand or automatically endeavour to keep the vessel at that depth by turning or stopping the propellers whenever the manometer showed that the required depth had either not been reached or had been exceeded. However

Disadvantages of System



CCXIX.

accurately a mechanical contrivance might be made for the regulation of this machinery, there is little doubt but that a boat fitted in this way would steer a very erratic course, the depth of the deviations in the vertical sense being regulated by the amount of reserve buoyancy. The course of these submarines was found on experiment to be 'jagged,' since the action of the propellers prevented the deviations being made in the long smooth swoops that characterises the 'errors of route' of the submarines fitted with horizontal planes or rudders. A glance at Fig. CCXIX. will make my meaning clear.

We will presume the submarine Z fitted with submersion propellers is desirous of attacking a hostile war-ship X. Having reached the 'limit of visibility' it becomes nccessary to submerge and the vertical screws are therefore set going and, as the submarine boat is presumably still in motion on its course towards the battleship, it will sink in a slant M M.

Having reached H the propellers stop but a slight momemtum will undoubtedly carry the vessel below the line required. Now since the vertical propellers have ceased to work, the submarine, although going steadily on its course, will, owing to the slight reserve of buoyancy, gradually rise above the designed depth until a point N is reached at which the propellers again commence to work automatically. This sort of thing will go on whatever precautions are taken and however carefully the mechanism is graduated, and as each rise takes place, so will the propellers start rotating and bring the vessel back again to positions such as A, B, C.

Advantages of System

Of course there are advantages to balance the disadvantages, and of these the most important is the preservation of an even keel. Again vessels fitted with vertical propellers have the power of immediate submersion, a power denied the other type of boat. Yet the very fact that vessels so fitted find no place in modern navies, seems to show that the faults of the principle out-weigh the virtues thereof. The acme of perfection in vessels of this type (if indeed such has ever been reached, which is doubtful) was attained by Mr. Waddington, whose boat showed a careful study of detail, a study too often omitted in the survey of the *tout en semble*, yet so very necessary for the making of an efficient craft.

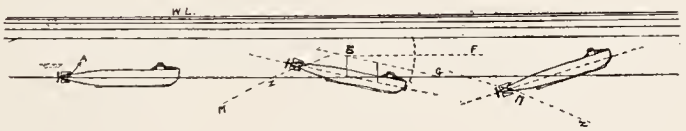
Submersion by Horizontal Rudders.

When a vessel is surrounded on all sides by an element of equal density the action of rudders is as effective in steering a vessel in the vertical plane as in the horizontal; hence rudders placed along the side of a vessel will augment or decrease the depth of submersion according to the direction of incline, in the same way that ordinary rudders by alterations of the helm, turn the vessel to either port or starboard as the case may be. This method of causing submersion, although not as ancient (?) as that by the vertical propeller, dates back to 1809 when the brothers Couëssin fitted rudimentary side planes to their boat 'Le Nautile,' and later in 1823 by Montgery. Its failure in the case of the 'Plongeur' of Bourgeois and Brun is too well known to require recounting, and its first practical adoption on the Whitehead torpedo is a matter of history.

Couëssin
Montgery
Bourgeois and Brun

Effect of Horizontal Rudders

Now let us discuss for a moment the effect of horizontal rudders on the movement of a boat when submerged. In Fig. CCXX. a submarine boat is fitted with horizontal rudders at A. Now if these rudders are inclined downwards the nose of the submarine boat will also dip as in the second plan, the speed of the water caused by the forward motion rushing off at a tangent in the direction of the line M Z. Now as this water is being forced out of its natural trend, its inclination will be antagonistic to the power compelling its deviation. Hence the boat being suspended as it were in an equilibrium will give before the strain exerted, and either rise or sink according to whether the planes are raised or depressed. And if a line F E been drawn parallel with the surface water-line to meet a line parallel to one drawn through the direct course of the diverted submarine, such as E, the angle F E G is the 'angle of inclination' the standard measure for gauging the power exerted by the horizontal rudders at a given depression or the reverse.



CCXX.

It will be understood that a submarine with positive flotability will always have a tendency to rise to the surface, and it is almost impossible that rudders could be so balanced that they would keep the vessel on a perfectly level course. This might be done, and indeed has been done for a set speed, but the moment that speed is exceeded or diminished the units of force exerted by the fixed inclination of the rudders become altered, and the reserve buoyancy will in the case of diminution of speed tend to bring the vessel to the surface, whilst if the speed is augmented the power of the rudders increases and the buoyancy would not be found sufficient to counteract their downward persuasions. Hence the course of a submarine of positive buoyancy must resemble that of a torpedo, *i.e.*, long smooth 'swoops.'

In Fig. CCXXI. I have represented the direction of movement as followed by a submarine. Of course the deviations

here depicted are enormously exaggerated, as the vessels of the 'Holland' (American), and 'Lutin' (French) Classes keep their depth within a few inches, so exactly have the controlling weights been arranged. Yet the 'Gustave Zédé' during her first trials must have made even deeper 'swoops' than those shown, and the feelings of her crew during these tricks can be better imagined than described.

CCXXI.

Means of Manipulation

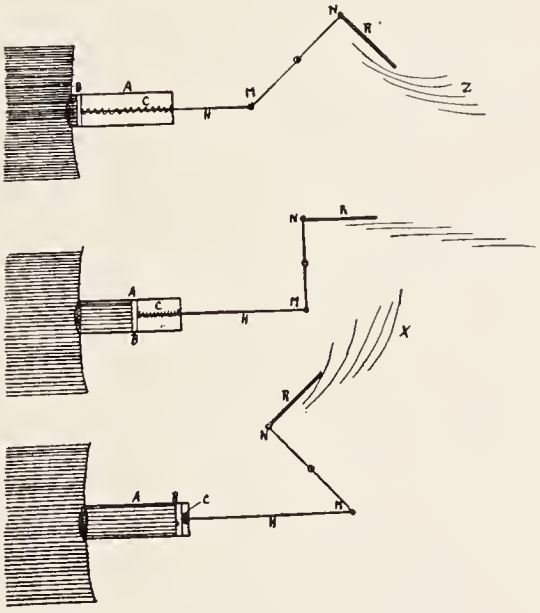
Let us consider the means of manipulating these rudders so as to preserve the smoothest possible course. There are three methods available, by hand, hydrostatic cylinders and by a swinging weight. Of these the two last alone concern us, the possibility of keeping a straight course by manual power being out of the question; since the strain of continual watching and the nervous tension resultant on this strain would soon wear out the limited crew of a submarine. They have besides so many other things to attend to that all that can possibly be accomplished by mechanical means is so done.

The Hydrostatic Cylinder

First let us take the hydrostatic cylinder. In Figs. CCXXII.-CCXXIV. A represents the cylinder, B the piston, and C the spring; R is the rudder. Now if the spring C is set at certain tension for a required depth, and if the vessel remains at that depth, the piston will remain half-way down the cylinder as in Fig. CCXXIII., the pressure of the spring and the ambient water being equal. The rudder worked through the pivoted rod M N, will be straight and the course of the vessel even. But having a reserve of buoyancy, there is the inevitable tendency to rise, and this being done on an even keel would not be effected by swinging weights. Here the spring begins to act, for as the density of the water decreases the strength of the spring becomes greater than the external pressure of the water and in forcing out the piston the rod H draws the lever M N in such a manner that the rudder is depressed as in Fig. CCXXII., and the water flying off at a tangent Z exerts the pressure necessary to bring the vessel down to the designed depth, when the force of the spring is again equalized by that

of the water outside and the rudder assumes the position of Fig. CCXXIII.

Similarly if the nose of the boat through the movement of one of the crew or other cause, be forced downwards, and the vessel dives below its proper line of submergence, the external pressure of the water will by its superior power compress the spring and move the rudder through the rods H and M N to the position in Fig. CCXXIV. The water following the curves X will have the obverse effect to that produced by the wave lines at Z in Fig. CCXXII. and the vessel will again return to the required level.

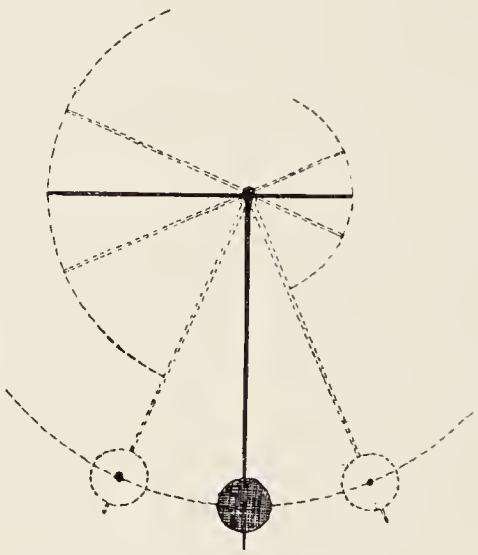


CCXXII.-CCXXIV.

The Pendulum

This idea is very ingenious and was first applied in practical form by Mr. Whitehead to his torpedoes, and has been brought to a state bordering on perfection in the later types. But whilst it has proved adequate for maintaining the good running of torpedoes (and the smaller submarine boats of the 'Goubet' and 'Drzewiecki' class) it has been found to possess insufficient strength for the guidance of the larger vessels, and to aid it in its task a swinging weight has been added. The principle as illustrated by Fig. CCXXV. is that of a pendulum, but of course in so delicate a machine as a submarine boat no

object with the freedom of a pendulum is permissible, and hence a cunningly devised system of springs is employed as a controlling agent and with the combined methods of pendulum and hydrostatic cylinder we have reached a stage when the movement of a submarine when submerged is almost as level as that of a vessel on the surface.



CCXXV.

Position of Rudders

With the modern vessels of all the Powers the rudders are worked through the medium of auxiliary motors whose action is regulated by the hydrostatic cylinder and pendulum above described. The most advantageous position for these rudders was for some time a matter of much speculation, but finally the stern has been found the best place, and not unnaturally for here the water, owing to the 'run' of the sides, has the greatest force, since the rudders strike it just at its highest momentum in its rush to fill up the 'hole' made by the boat in its passage through the water. That is to say the water displaced gathering speed from the moment it is divided by the prow of the vessel, attains its highest velocity at the stern, and hence the action of the rudders is, on the face of it, bound to be more potent than at the sides or in the bows.

But whereas with short stumpy vessels such as the 'Holland' these stern rudders are all that is necessary, with long

thin craft of the 'Morse' type, their action is not sufficiently sharp, and the helm is not answered with the necessary promptness. In this case lee-boards or bow fins become a necessity, although in adding such to the stern horizontal rudders, it must always be remembered that too much handiness on the helm is apt, where submarine boats are concerned, to be almost as disastrous as insufficient rudder power.[1] A vessel having too many of these rudders would stand a good chance of turning right over, for if in the flurry and excitement of battle the helmsman were to put the helm hard down, the nose would turn almost vertically downwards and the probability is that the engines, motors and all interior fittings would be wrenched from their fastenings and precipitated through the hull. At all events the vessel and crew would be doomed, for in a few seconds a depth would be reached, at which the pressure would be too great and the vessel would be crushed out of all recognition.

Danger of Rudders

B. Floatability Nil.

This condition was for a long time considered impossible of realization, but since the experiments of M. Goubet and Drzewiecki, much information has been published on the subject. The possibility of such a state as 'suspension in equilibrium' has been long recognised, this being but a natural sequence of deduction on a knowledge of the pressures of liquids. Thus if between a depth registering a pressure of 30 lbs. to the square inch and one having a pressure of double that, be placed a vessel the displacement of which is such that its buoyancy prevents its sinking as far as the 60 lb. pressure limit and yet is insufficient to raise it to the depth having a pressure of 30-lbs., it will be suspended between these two pressures in equilibrium. But so little force does the pressure of

1 The following is an instance of the danger of too much helm power. 'The Diadem' class of cruisers require about a mile to turn in, the 'Arrogants,' known as the handiest ships in the Navy, have a turning circle of little more than their own length. During some recent manœuvres one of the Arrogant class chanced to be in line ahead of a Diadem, and a turn to port was ordered. The Arrogant whizzed round at once, but the Diadem, owing to her much greater turning circle, came round slowly, and only just escaped cutting the second class cruiser in two. The fault lay in placing two vessels so absolutely different close to one another.

water exert on immersed bodies that the addition of a trifling weight would cause this suspended vessel to sink down very much deeper, and in the same way the slightest diminution of weight will bring it to the surface. In M. Goubet's second boat a *glass full of water* added to the tanks after the weight of his vessel has been reduced to nothing is sufficient to sink it several inches, and the difficulty of dealing with ounces in a vessel whose weight is counted in tons can be easily imagined. Yet to so high a state of perfection has this inventor brought his boats that in spite of currents and changes in temperature (both of which have a decided effect on the suspensory powers of water) he can keep them suspended motionless a few feet from the surface.[1] Unfortunately the moment his boats are set in motion their quality of suspension is destroyed and all the endeavours of their talented inventor have as yet failed to keep them on a straight course.

Balance of 'Goubet II'

The addition of a hydrostatic cylinder to a pair of horizontal rudders will considerably augment the feasibility of maintaining a vessel of a 'floatability nil' in suspension when submerged, since the weight of the boat being equal to the weight of the water it displaces, the effect of the hydrostatic cylinder will be infinitely greater than with a vessel of 'positive buoyancy.'

Without entering upon technical explanations of the various and ingenious apparati employed in the process of submersion,[2] I should like to mention one more method of sinking a submarine boat that may even yet be tried in modern vessels, *i.e.*, by reduction of volume. This was first proposed by André Constantin in 1870, his vessel being fitted with two hydrostatic cylinders with accordeon shaped pistons. Campbell and Ash increased the number of cylinders to ten, and placed five on each side of their boat, whilst Cavett, Ryan and S. and G. Rogers preferred to make their inventions telescopic. It can be understood that with a small thread extension screw it might be possible to manipulate this type of fitting to a nicety and perhaps had the question received a little more attention than it has done up to the present a serviceable vessel

André Constantin

Campbell and Ash

Cavett Ryan

S. and G. Rogers

1 See M. Emile Duboc's account.

2 Some of the best known of these are by Goubet, Noalhat, Brin and Chapman, etc.

depending on reduction of volume for submersion might by now have been invented.

Danger of Floatability Nil

There is always this danger to be faced with submarines which retain no reserve of buoyancy. In the event of the crew becoming suffocated, or unconscious through the escape of noxious fumes, the vessel would not have the power to rise to the surface, and with a body in suspension the tendency is always to sink. The fate of a crew so situated is awful to contemplate. If as would be the case of a vessel of 'positive buoyancy,' it rose to the surface, there would at least be a chance of being seen and picked up before anything fatal had occurred.

C. Negative Buoyancy.

Simon Lake's 'Argonaut'

The question of submarines of 'negative buoyancy' need hardly be discussed, although perhaps the submarine explorer of M. Simon Lake would come under this head.

II. Stability.

Definition of Stability

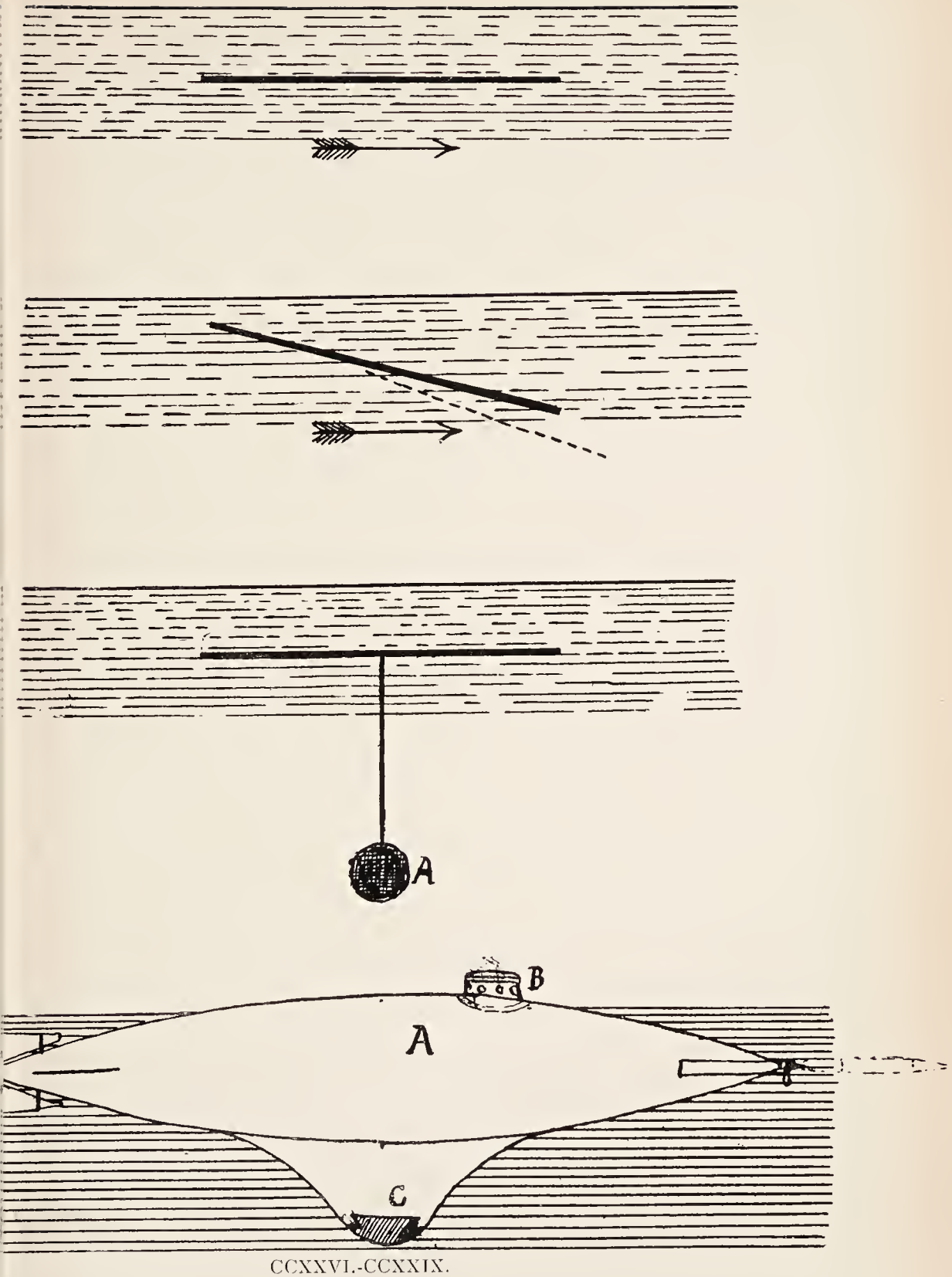
Stability is the all important feature in a submarine boat. A 'submersible' vessel without this quality is practically useless, and the conquest of this seemingly insuperable difficulty is one of the great mechanical victories of the last century.

Stability with reference to submarine boats might be defined as the keeping of such craft on a level keel and counteracting promptly and effectively any endeavour on its part, should it dive, to follow the line of least resistance. In an old issue of 'The Engineer' [1] appeared some very astute remarks on the subject of stability. It is a well-known fact that if any shape is moved through the water it will always take the line of least resistance. If, for example, a plane be moved through the water as in Fig. CCXXVI. in the direction of the arrow, then it will continue to move horizontally, because in that position it offers least resistance. If now we attempt to move it in the direction of the arrow when inclined as in Fig. CCXXVII. it will at once proceed following the line of least

1 February 8th, 1901.

resistance to dive as shown by the dotted line. For this reason it is clear that the submerged boat will always 'follow her nose' in the literal sense. Now there are considerable difficulties in the way of knowing whether the head of the boat is pointing down or up, with any promptitude; and, so far it has been found almost impossible to preserve an even keel and at the same time move at a high velocity under water. Of course this does not mean that short spurts have not been made, but this has been far more as the result of chance than good guidance, and for this reason automatic horizontal rudders and other devices have been tried. These are fairly successful with torpedoes; but the torpedo moves at such a high speed, and the conditions are so different from that obtaining with a submarine boat—no moving weight within it changing the position of the centre of gravity—that no correct parallel can be drawn. Rudders and fins were tried in the Garrett boats, but they were very inefficient. The tendency of all such devices is to hunt! They cannot anticipate and they always overdo their duty with the result that, as is well known, the boat is continually rocking up and down if any progress is made through the water. The only certain remedy for this is to give longitudinal stability by concentrating a heavy weight about the centre of the length of the boat. If for example we attach to the plane shown in the first two figures an arm with a weight appended, as in Fig. CCXXVIII. we shall then have longitudinal stability.

The balance bob at A will always tend to rectify every departure from the horizontal, and it would not be difficult so to arrange matters that the angle between the ballast arm and the flat plate might be changeable, so that the whole could be made to dive or ascend to the surface. It is obvious, however, that the arrangements sketched would not answer in practice, and the form of the submarine boat would therefore be not very unlike that of a racing yacht as shown in Fig. CCXXIX., which is a longitudinal section, A being the body of the boat, B the conning tower, and C concentrated lead ballast. It is evident that in this way we can obtain all the longitudinal stability desired. But it must not be forgotten that it is far from being the stability of a boat floating on the surface. The bob weight can only diminish the angle of in-



CCXXVI.-CCXXIX.

clination due to the shifting of weights inside the boat. It would, however, probably suffice; on the other hand the ballast thus applied would greatly augment the draught of the boat —a fact which might, under many conditions, tell heavily against her.

That this bulb-keel idea has never yet been tried seems to point to the fact that it is better in theory than it would prove in practice. There are only two methods of maintaining longitudinal stability, but these two are sub-divided into many divisions. They are by means of (a) water-tanks and (b) by 'moving weights.'

A. Alteration of Water-Ballast.

Goubet's Method

The first system we will study is that adopted by M. Goubet; this apparatus consists of two large circular water-tanks connected by a stout pipe. In the centre of this pipe rises a pear-shaped dome containing (a) a pendulum, (b) a rotary pump, (c) pipes connecting the two tanks. The method of working is as follows:—Should the vessel incline in any direction the pendulum swings forward (marking the extent of the deviation on a dial above the dome) and in so doing forms a connection between the motor and the accumulators or batteries, when the former at once commences working the rotary pump in a direction which causes the water to flow through the pipes from the lower tank to the higher, until the addition of water to the latter is sufficient to bring both the boat and tanks level again; the pendulum swinging straight then cuts off the electric current and the motor instantly stops. This system has been found to work very well when it is the 'trim' of the vessel that requires rectification, but for 'stability of route' it is essentially faulty for two reasons. Firstly because it takes some time for the mechanism to get to work, and secondly when the motor has been started it is a difficult matter to cause its immediate cessation, and consequently the water goes on flowing until too great a quantity has passed and the boat will assume an incline in the opposite direction. This causes the pendulum to swing to the other side and the same thing applies. Hence, the movement of

the Goubet boats when in motion resembles the swing of a scale beam, and were it not for their remarkable natural stability, owing to all the weight being in the centre section and well below the centre of buoyancy, the motion of these boats would be unbearable. At the speed of which they are capable, however (never more than six knots) this swing is scarcely noticeable. The system whatever its faults is ingenious and well worthy of the inventor.

F. Forest's Method

M. F. Forest's method of regulating the longitudinal stability, although resembling that of M. Goubet in principle, differs therefrom in detail. I am reproducing M. Forest's own description of this invention.

'A chaque extremité de la coque se trouve placée une chambre étanche contenant une certaine quantité d'eau variable suivant les dimensions du bateau; ces deux chambres sont réunies par un fort tuyau branché sur une pompe rotative système Gremdt, laquelle peut fonctionner dans les deux sens de rotation pour amener l'eau du réservoir d'avant et la refouler dans celui d'arrière et vice versâ, suivant les besoins de la stabilité.

'Cette pompe est actionnée par une dynamo marchant égale ment dans les deux sens.

'Ces appareils sont tous la dépendance d'un niveau à mercure, construit sur le principe des niveaux d'eau des arpenteurs. Il se compose d'un tube horizontal en fer, de plusieurs mètres de longeur, et de deux éprouvettes (=gauges) verticales en verre. Le tube est rempli de mercure, et les deux éprouvettes jusqu'à moitié environ de la hauteur.

'Dans chaque éprouvettes plongent deux tiges métalliques qu'on peut amener à quelques millimètres de la surface du mercure; une des tiges est reliée à quelques accummulateurs et l'autre commande la dynamo motrice de la pompe centrifuge.

'La moindre denivellation de l'axe longitudinal du sous-marin amène le mercure en contact des deux tiges métalliques et ferme ainsi le circuit qui doit actionner la dynamo dans le sens de rotation nécessaire pour rétablir la stabilité horizontalé rompue par une cause quelconque, notamment par le déplacement des hommes de l'équipage. Le poids d'eau déplacé est égal á la moitié de la charge qui a momentanement rompu cette horizontalité.'

This invention is highly ingenious and is undoubtedly an advance on that of M. Goubet. The means of preserving stability by horizontal rudders hardly needs explanation, this being a variety of methods all equally practical. The two methods of maintaining horizontality described above are also very ample to show the principle on which all water-ballast manipulation is worked out and I will therefore go on to a short discussion as to the most adaptable form or shape for submarine vessels.

III. Form.

The Wave Line

If the effect of form is important in the calculation of resistance to surface vessels it is doubly so to submarine craft. But whereas in ships on the surface the wave line is the leading feature to be studied, with submarine vessels this naturally requires no consideration, the chief point in view being to obtain a form conducive to speed and stability.

On the surface a vessel in motion throws off waves and these disperse on either side at an ever widening angle until the force of contact with the vessel shall have become nullified and the wave subsided to the ordinary surface condition of the water. It will be seen that there is here a considerable amount of wasted energy, for in return for the power expended in cleaving the water the ship receives very little or no help in its forward motion. Let us take the case of the submarine. When such vessels divide the water, the displaced fluid being unable to follow the course of the surface waves and radiate, owing to the incompressibility of the ambient water, closes in behind the object in movement. We thus see that a great deal of the energy expended in parting the water in the bow is made up by the forced return thereof to the position it had held prior to meeting the resistance of the moving vessel, and in so doing aids the onward movement of it. Now the gain or loss of such help depends solely on the form, or 'run' of the after part of the boat and it is alterations in the shape of this portion that govern the entire outline of submarine boats. On the appended plate I give six sketches of the chief forms adopted in the construction of subaqueous vessels, and a short

study of these will help us to understand the why and wherefore of many uncertain points in their trials, and the reason of their success or failure.

No. 1 is the symmetrical form adopted in a large majority of boats; amongst these we may mention the 'Gymnôte' (as represented), 'Goubet,' 'Baker,' 'Rutley,' 'Philippeau,' 'Freese and Gawn,' 'Piatti del Pozzo,' 'Forest,' 'Peral,' 'Waddington,' 'D'Allest.'

No. 2 represents a fairly common type of dissymmetrical vessels which includes the 'Plunger,' 'Drzewiecki,' 'Katahdin,' 'Lecaudey,' 'Tuck.'

No. 3 is a shape peculiar to the well-known 'Holland' boats, the chief feature thereof being the position of the greatest diameter. Another very similar is the invention of 'Lacavalerie.'

No. 4 represents the shape I have adopted in my armoured vessel and combines the excellent form of the 'Holland,' with the flat resistant upper surface of the 'Gustave Zédé.'

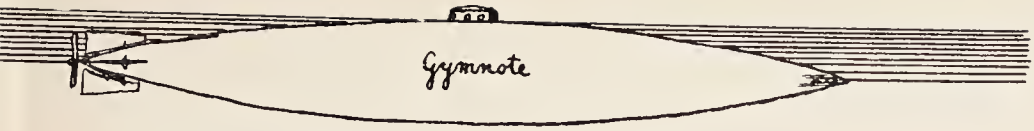
No. 5 including the 'Gustave Zédé' and 'Morse' presents a form in the bows much conducive to surface stability, a quality more valuable in a submersible than a true submarine.

No. 6 Mr. Nordenfelt's ill-fated Russian submarine boat shows some novelty of form, but it is too much of a surface vessel to be an efficient submarine.

Discussion on Various Forms

Form I 'Gymnôte' and 'Goubet'

We will now discuss each of these in turn and endeavour to find out their several points of interest. In the 'Gymnôte' we have a form which whilst possessed of little longitudinal stability represents the maximum of resistance. There is nothing so capable of withstanding enormous outside pressure as a sphere, and next in strength comes the double-ended cone. For the exploration of great depths therefore, the form adopted by M. M. Gustave Zédé and Goubet presents every advantage, but I fail to see the value of this advantage, if such it be. The 'Goubet' as we know is capable of withstanding the pressure at a depth of about 5,000 feet or very nearly a mile beneath the surface; our own 'Holland' is capable of navigating safely at 150 feet! The difference is astounding; even if we allow the 'Holland' a margin of safety equal to 850 feet (an altogether disproportionate allowance), the 'Goubet' is yet five times as capable of withstanding external pressure as



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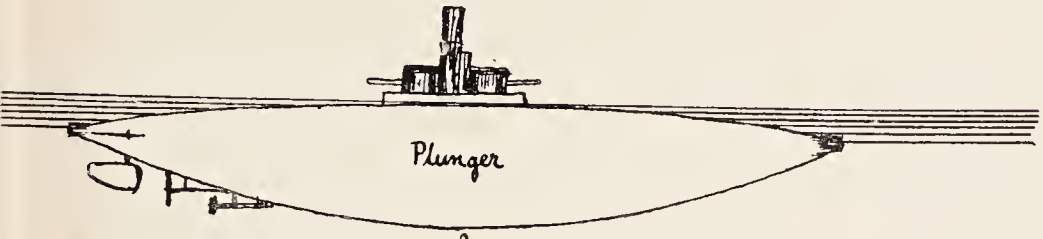

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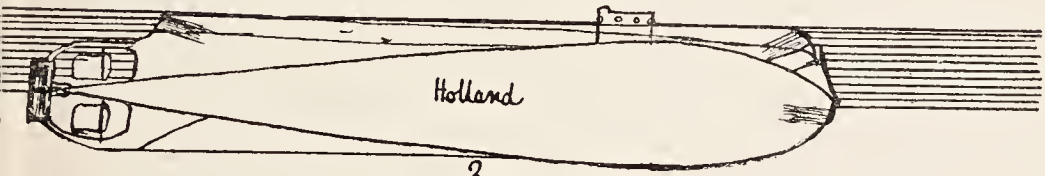

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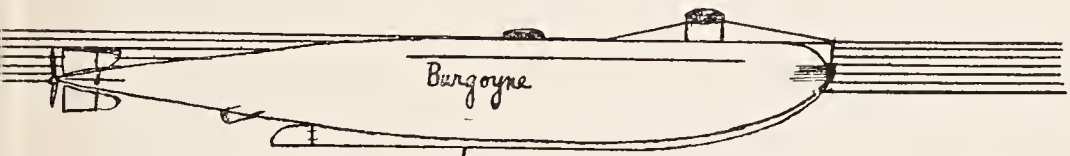

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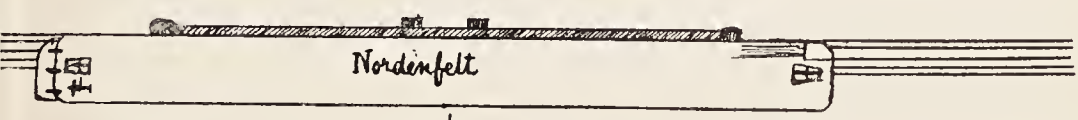


6.

CCXXX.-CCXXXV. VARIOUS FORMS OF SUBMARINES

the American boat. The value of this immense strength is however, not apparent, and there is little doubt but that any advantage it may confer is negatived by the lack of stability attached to this form. The reason of this is easily comprehensible. The vessel is circular in section from stern to stern, and is balanced as a beam by its preponderance of weight in the middle. Now this all-round equality of sections renders a see-saw motion in the longitudinal sense the easiest possible thing since there is no variation of resistance at any point, and differentiation in the locality and distribution of such resistance is a greater step towards stability than the action of rudders and changeability of water-ballast can ever be. Thus if a member of the crew of a symmetrical vessel walks forward and so causes the bows to dip, the resistance of the water to the lower contour of the forward part of the hull is equal to the resistance of the upper part of the stern section and the diving angle of the vessel being even over its whole length the deviation is not lightly obviated and a swing motion is set up which besides being dangerous to the vessel should the depth of water in which she is navigating be little, is decidedly unpleasant to the crew, whose pluck and hence value would soon disappear under the prolonged tension of essaying to keep their craft on an even keel. The Turkish sailors absolutely refused to serve on the 'Abdul Hamid' and 'Abdul Medjid' owing to their switch-back like movements when submerged, and although greater courage and less superstitious fear of death might be found in the sailors of a first-class Power they would accept the appointment to such vessels as the 'Nordenfelts' with very poor grace. Of course this defect in stability is not irremediable, for in the 'Goubet' we find the acme of stability, and yet she is of the symmetrical form. This is owing to the height of the centre of buoyancy and the size of diameter as compared to the length. Thus it was only natural that faults which were prominent in the 'Gymnôte' should be accentuated in the 'Gustave Zédé' a vessel of far greater length with little additional beam, therefore the shorter a symmetrical shaped vessel is as compared to its diameter, the nearer does it approach a sphere weighted at the bottom, and the greater will the stability be. But in obtaining this necessary stability the fine lines essential to speed disappear,

and speed is of almost as much importance as evenness of route when submerged. If a compromise is effected we obtain a vessel faster than the 'Goubet' but less stable. Such a boat is the 'Gymnôte,' and the 'Gymnôte' in all probability represents the final phrase of the symmetrical submarines.

Form 2 'Plunger'

Let us see whether we have made any advance in the shape represented by No. 2. This form was adopted for the 'Plunger,' an armoured American submersible, which is at present lying in a small harbour on Long Island, 170 miles from New York, a mere hollow shell. It is no novelty as regards design, having appeared in Professor Tuck's two boats, both of which it will be remembered, were failures. The same remarks made of No. 1 apply to No. 2, therefore, since we find in the 'Drzewieckis,' vessels almost analogous to the 'Goubets,' having their great stability but lack of speed. For surface vessels of the submersible type, amongst which we may name the 'Katahdin,' (the 'American Ram,') and the 'Polyphemus' an English design, this shape has its advantages. Firstly it lends itself readily to the application of an armoured deck along the top, a matter of the utmost importance to vessels whose sole weapon of offence is the ram, and secondly because the gradual slope towards the extremities tends to invisibility when partly submerged. Unfortunately with this shape, great speed after a certain velocity has been attained (from 14 to 16 knots) is found impossible owing to the enormous wave resistance, which even a great increase in engine power cannot overcome. If we refer to the trials of the 'Katahdin'[1] the difficulties encountered will be at once seen. For submarine boats proper this form seems to offer some slight advantages over that first discussed, but not sufficient to merit its adoption for modern vessels. Symmetry of outline cannot, owing to the equal distribution of resistance (as explained above), ever be successful in submarines, and this fact was early grasped by both France and America, the two nations that have taken most interest in submarine navigation. Another form was therefore sought, and that two efficient solutions have been discovered for the problem of 'shape' has been proved by the repeated success of the latest boats built by our American friends and our neighbours

[1] Vol. I., page 185

d'outre Manche, both of which types are as different one from the other as a Great Lake whale-back is to a West African liner. A glance at the plans shows the main features of these two designs as represented by the 'Holland' and 'Gustave Zédé.'

Form 3 'Holland'

In the 'Holland' we have perhaps the nearest approach to Nature's submarine, the fish, that it is possible to obtain. The heavy forward part and the fine diminishing tail are the great features of all the Holland craft. This form is so stable that oscillation is entirely absent when submerged, especially in the first 'Holland' designs which are short and stumpy. For although the weight is unevenly distributed, the equilibrium is perfect, owing to the fact that in the bows which support the major portion of the weight the buoyancy is greater and can thus sustain it, whilst towards the stern the gradually diminishing surface of the hull reduces the buoyancy power and thus equalizes the pressure evenly over the whole length of the vessel. For obtaining high speeds this shape is exceptionally favourable, resembling as it does the shark, dolphin and other fish noted for their speed, and that a greater velocity has not yet been obtained is due to the stumpy form adopted. This will in time lengthen out just as modern battleships, which started at 325 feet in the Admiral Class, have reached 405 feet in the six Duncans now completing, and in a short time the submarines will rise above the stigma of 'slow ducks' at present applied to them. It will have been noticed that the sharp pointed bow has given way to a blunt nose, and this is due to the same reason that changed the form of the stem of the White-head torpedo from a point to a spherical cone. It was found by experiment with models in a tank that the sharp nose, strange as it may seem, offered infinitely greater resistance to the water when in motion than an equal sized model with a rounded blunt nose. This phenomenon may be roughly explained as being due to the difference of flow of the liquid wave of motion when caused by a sharp point and a blunt point; thus if a sharp point pierces the water, the fluid is 'forced' on either side and strikes out at an angle away from the hull, whilst with a blunt and smooth stem the water 'glides' away from the impact and swirls smoothly 'round the lines' of the hull instead of wasting its energy on the

Value of Blunt Nose

ambient water in an ineffectual effort to compress the same. This argument does not apply to surface vessels owing to the difference between 'surface wave resistance' and 'submerged wave resistance.' As a matter of fact, it is erroneous to say 'submerged wave resistance' there being no 'wave,' but for want of a better term, the word 'wave' will stand very well for the radiating lines of moving fluid displaced by a submarine boat in motion. On passing the thickest part of the boat which is about a third of the length from the bows (in the design the greatest height and diameter have been placed rather far forward, in order to accentuate the difference in form from the other types illustrated), the flowing water rushing sternwards to fill the cavity out of which it has been forced, presses tightly on the receding lines of the hull and the longer the stern 'run' (that is, from the greatest section to the propeller) is, the greater is the length of time that this pressure is exerted, the velocity of the backward flowing current is likewise augmented increasingly as it reaches the end, and these two causes (the rapid flow of the displaced water and its pressure on the hull) help the forward motion of the boat and make up almost entirely any power lost through resistance. Of course it would be foolish to say that the ideal shape had been already discovered, but the 'Holland' is very nearly all that can be desired. An ideal submarine vessel would be one in which the frictional resistance was completely made up by the sternward pressure, but this is as likely of attainment as universal peace. The 'Holland' form is of course a compromise, and it is not therefore unnatural that a weakness should exist and that is, in strength. As has been mentioned above its limit for practical purposes has been placed at 150 feet depth, and this although ample for ordinary work hardly allows sufficient margin for unlooked for events. Perhaps, however, the limit of safety would permit twice or even three times the depth to be reached without great danger, but this can scarcely be ascertained otherwise than by theory there being few who would care to undertake a personal experiment. The stability of the 'Hollands' when firing torpedoes is infinitely superior to that of the French submarines, which even with all their compensators are now and again very ready to stand upright on their tails the moment

Action of Water on Hull

the discharge of the torpedo has lightened them in the bows.

Form 4

The shape represented by No. 4 is an endeavour to combine the best features of the 'Holland' and 'Gustave Zédé.' Like the 'Holland' in every other particular, this vessel is provided with bows very similar to those of the 'Gustave Zédé,' and whilst perfectly fitted for submarine navigation possesses the additional advantage of being a good surface boat owing to the torpedo-boat stem. This, in a submersible, is of the utmost importance, and it is therefore strange that the 'Holland,' which is as much a 'submersible' as a 'submarine,' should have the bows of a true 'submarine,' and that the 'Gustave Zédé' which is a true 'submarine' boat should have a stem more suited to a 'submersible.'

Form 5 'Gustave Zédé'

Passing on to the 'Gustave Zédé' we find a fault at once,—a fault, however, which the skilful engineering and inventive ingenuity of our neighbours have been able to counter-act. This fault is too great a length in comparison to the diameter. The more this is so, the more must the movement of the vessel in the longitudinal sense savour of the switch-back. Any weights at the ends tend, if decreased or augmented, to utterly destroy the equilibrium of the vessel, the leverage being so infinitely greater than in a short deep boat. Hence when first tried, the 'Gustave Zédé' progressed in long, sickening dives, the stern rudders or planes being totally incapable of keeping her on a straight course for two minutes together. The addition of two other pairs have now made this submarine boat one of the most efficient in commission, her movements being wonderfully steady.

Form 6 'Nordenfelt'

Of the 'Nordenfelt' we will not speak. We know that she rocked like a beam every time she was submerged, and that no power on earth would keep her on an even keel. Her disastrous end off Jutland is a matter of history.

There have been here and there in the list of inventions of submarine boats, vessels of a novel and out of the way shape which could be said to belong to neither of the six forms cited. Of these Paul's boiler—shaped submarine, Sir Gerald Strickland's invention, and the ideas of Messrs. Middleton, Urzua-Cruzat and Pool are the most curious, but of course neither of these approach the weird contrivance of W. A.

Leggo, which for absolute novelty of design and absurdity of conception can be said to hold the palm.

IV. Orientation.

I cannot do better than reproduce the 'Engineer's'[1] translation of a portion of M. Gaget's[2] chapter on Orientation and Vision when submerged.

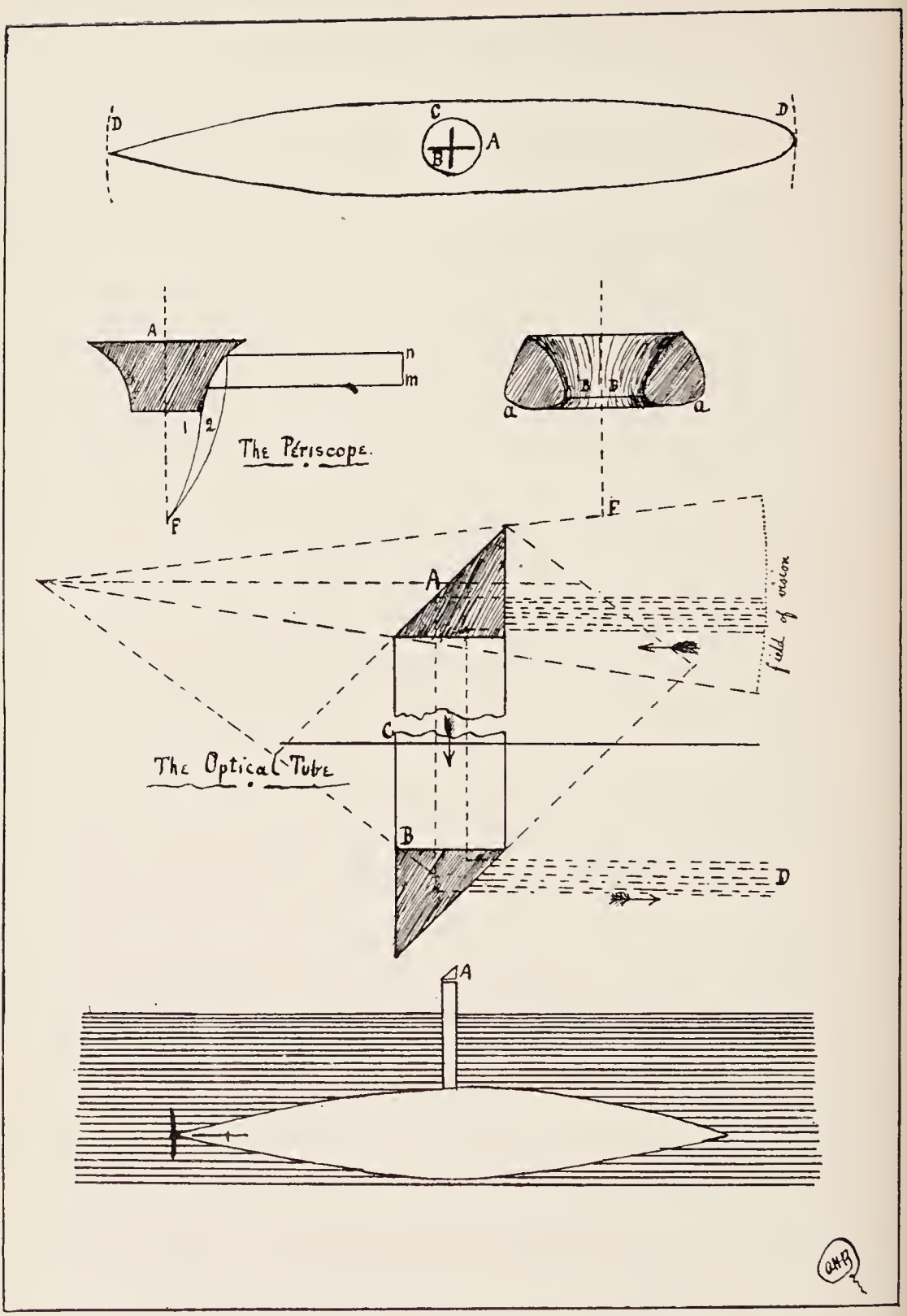
Two Essentials

Let it be supposed that two essentials have been provided in a submarine boat, namely, longitudinal stability and adequate means of propulsion; still she will be useless, and even in danger, unless some method of directing her movements can be supplied. It must never be forgotten that if the boat is to work without discovery, which is essential in submarine operations, she must descend to such a depth that at least 15 feet of water is always above the highest portion of her. With more moderate immersion if the sea is rough, she will run the risk of showing in the trough of a wave, in a way well understood by those who have seen the whales at play. Indeed, as the submarine boat cannot live in disturbed water, she must descend far enough to get well below the level of the waves. Even in clear weather and clear water nothing can be seen a few yards from the boat, which appears to be surrounded by a curious haze of light, and this is broken up and put in motion by the action of the waves above in a way that has been compared to the effect which is produced in a room near the side by reflection from the waves through the narrow openings left in a Venetian blind when nearly shut. From this it follows that the submarine cannot possibly be steered by direct vision. We have, then, two methods of guiding her by indirect means, which we shall now proceed to consider.

The simplest and most obvious system consists in running the boat above water as near as may be to the object of attack; taking the bearings of the object by compass; then sinking to the required level; and, lastly, steering by compass to striking distance and then firing the torpedo.

1 February 15th, 1901.

2 'La Navigation Sous-marin,' Maurice Gaget, 1 Beranger, Paris, 1901.



CCXXXVI.-CCXL. METHODS OF ORIENTATION

We have already discussed this scheme in some detail, but something remains to be said with advantage. Let it be granted that the bearings are accurately taken, and that the course steered is quite correct. There remains the apparently insuperable difficulty of knowing when the proper distance has been traversed. In the first place, the distance will have to be estimated by the steersman in the conning tower before the boat is submerged. It is very doubtful that accurate results could be obtained, unless in very still water, with a range-finder. But granting that he knows that the iron-clad to be attacked is exactly one mile 300 yards off, and that the torpedo is to be fired at 300 yards range, how is it to be ascertained that the submerged boat has run precisely one mile? Spinning logs are notoriously inaccurate over short distances. If the distance run is to be settled by the revolutions of her propeller, then she must in the first instance be carefully calibrated, and after all, any currents in the water would upset all calibrations. But these facts do not cover the whole ground. So far it has been found impossible to construct a perfectly trustworthy compass, even for a steam or oil-propelled submarine boat. In an electrically propelled boat there is so much free magnetism flying about that no compass is of any use whatever. It is to be remembered that the standard compass in an ordinary steel ship stands on the bridge or on a tripod high above the hull; but in the submarine boat the compass is inside—within so to speak the very body of a magnet with all sorts of consequent and inconsequent poles. So entirely untrustworthy and impracticable is steering by compass, that resort has been had in France to a totally different instrument, namely the gyroscope. If a heavy wheel be set spinning on a horizontal axis, it will resist any force tending to alter the plane in which it is revolving. That is the reason why a bicycle does not upset. If now, we set a heavy vertical wheel spinning in a submarine boat, the axis being at right angles to the keel, and if, furthermore we hang the wheel in gimbals then a prolongation of the axis may be used just as a compass needle.

The Gyroscope

In Fig. CCXXXVI. let A be the gyroscope seen in plan and driven by a small electric motor, B is the axis, C a curve on a graduated card. Now although the boat may swing to port

or starboard, as shown by the dotted curves D D, the gyroscope will not follow her motions, and every degree of swing at D or B will be indicated also in degrees at C by the pointer on the end of the axle. This is the principle of the instrument, which has been worked out very beautifully by French Instrument makers. Its operation is well summed up in the following quotation from a work on submarine navigation by Mons. Dessaint:—'Comme nous avons dit plus haut l'appareil accusera toujours la même route; le bateau s'en écartait, ou en serait averti par le deplacemente du limb sous l'index; il suffirait de ramener l'appareil au point primitif en governant convenablement, et le bateau reprendra sa route primitive.'

We have here a very beautiful theory. The gyroscope has been tried with a certain amount of success in submarine boats, and we all know that it has worked very well indeed in the Howell torpedo; but it is open to very serious objections. If by any means the plane of revolution of the gyroscope is altered, as by a shock or jerk, then it will continue to rotate in the new plane. Now let us suppose that by some means the head of the boat should diverge to the right or left, so that the axis of the gyroscope is no longer at right angles to that of the boat, and that at the same time the boat should roll, a slight angular displacement will be produced, and when the boat is once more on an even keel the gyroscope will no longer be revolving in the same plane in space, and its indications will be wrong. The displacement may be very small, but yet enough to make the boat miss her mark. However, with all its defects it appears that the gyroscope is the best indicator of route that has yet been devised. The difficulties and objections to its use in warfare are too numerous to be dwelt on in detail; yet if it were only possible to devise some method by which the distance run by the boat could be accurately known, submarine attacks on ships at rest in still water could be carried out with considerable certainty of success by the aid of the gyroscope.

Leaving devices which may be termed indirect, let us now turn to those intended to confer vision on the crew of the boat.

Périscope

We are indebted to M. Gaget's book for the first (?) pub-

lished description of the périscope about which so much has been heard. M. Gaget holds that it is entirely useless, and our readers will we think, agree with him. It is a very simple affair. Most of our readers have no doubt seen a pretty toy in which a silvered glass tube about one inch in diameter and six inches long set in a little stand plays a principal part. Objects converging round this give a distorted image on the side of the tube. With the tubes are sold cards bearing extraordinary and unintelligible curved devices. Place the cylindrical mirror in the centre of the card, and we have a true picture of a house, a face, a horse, etc., reflected in the mirror. The distortion of the card is corrected by that of the mirror. If instead of a mirror with parallel sides, we used a mirror a parabola in section, we should get a picture of surrounding objects no longer distorted but extremely minute in the focus of the parabola. This is the périscope. The principle of the instrument will be understood in a moment from Fig. CCXXXVII. Here A is a section of the cylindrical block the curved faces of which are silvered; at N M is any object say a ship. This will be reflected as shown, on the lines 1 and 2 to the focus F. The reflector is supported above the boat, and so arranged that the focus falls on a white card inside her. The result is a panorama of the surroundings of the boat about 1/8-in. in diameter.

The more accurate the instrument the smaller the picture and the better the definition. This picture to be of use must be magnified, that is to say, it must be looked at through the eye piece of an astronomical telescope. Anyone who has ever steered a boat will form some idea of the utility of the apparatus. In the shape we have sketched it could not be used at all, being too delicate, to say nothing of difficulties in fixing it. It therefore takes the form of a glass ring, in section as shown in Fig. CCXXXVIII. A moderate acquaintance with optics will suffice to show that the results obtained are practically the same as with Fig. CCXXXVII. The inner parabolic walls of the ring being silvered, and the rays being reflected down through the faces a B a B to the focus F. This ring it will be seen can be mounted on the top of a rigid tube. We agree with Mons. Gaget that 'son montage sur des tubes rigides et la disposition des écrans et des microscopes ne

valent pas pour le piteux résultat qu'on en tire, qu'on s'attache a leur détail.'

It may be taken as certain that the périscope about which the world heard so much is quite useless. It would be mere waste of time to consider it further. We may in passing, call attention to the circumstance that it never could be used as a float under any circumstances.

Optical Tube

There remains for consideration what is known as the optical tube. Its principle of action is very simple and precisely the same as that of the small mirrors which some people hang on a window jamb at an angle. Anyone sitting in the room can see reflected in the mirror what passes in the street below. Let us suppose a tube erected on top of the boat as in Fig. CCXL. and on top of the tube an inclined mirror A. Then anyone standing below and looking up would see reflected in the mirror much of the surrounding sea with ships, etc., as however this would be a very fragile and inconvenient arrangement prisms are used as in the Camera Obscura. In practice the arrangement is somewhat as shown in Fig. CCXXXIX. Here A and B are two prisms, the one A above the boat C, the other inside it. The course of the light rays is given by the arrows, and an observer at D will see before him, reflected, any object that comes within the angle of reflection of A, and unlike the périscope image no magnifying is necessary. But the optical tube has the defect that its field of vision is limited, and that the whole panorama can only be got by turning the instrument round on a vertical axis; and it is important to note that both the prisms must revolve; in other words the observer must follow the tube as it runs. The steersman cannot remain in one place and have the picture placed before him. A very limited portion of the horizon is visible, and the whole can only be seen, as we have said by sweeping the prisms round, just in short, as a pilot sweeps the sea with a telescope. This has been found very inconvenient, and attempts are being made to produce compound apparatus which will give, say, half a dozen pictures of the outer world instead of one.

Of the many trials that have taken place with the optical tube the most important is undoubtedly that of the 'Goubet II' on April 19th, 1890. The trials were made before many

noted men and several officers of the French Navy, including Admiral Réveillere; of the civil members present we may mention M. Labart-Denneville, deputy of Cherbourg, M. le sous-préfet, M. le procureur de la République, M. le commissaire central, etc. The trials which are worth recounting I am giving in the words of M. Vitoux, a reporter on the staff of a well-known French scientific paper.[1]

'Premières Expériences.—Les expériences ont commencé, vers dix heures, dans le fond du bassin du commerce, et ont été exécutées dans une eau assez limpide.

'Un petit radeau, mesurant 6 mètres sur 3 mt. 50, et mouillé au milieu du bassin, sert de port d'attache au 'Goubet' les assistants montent à bord de cinq torpilleurs ranges côte à côte et mouillés à quelques mètres de la tandis que les deux hommes composant l'équipage du 'Goubet' entrent dans leur bateau. Bientôt les amarres étant détachées, on voit le 'Goubet' s'éloigner du radeau, et, tout en s'enfonçant avec une lenteur extrême évoluer en divers sens; le torpilleur sous marin en ce moment manœuvre uniquement à l'aide de ses deux paires de rames, *dorsale* et *abdominale* dont le fonctionnement est comparable aux nageoires d'un poisson D'ailleurs, provisoirement, le 'Goubet' a dû retirer son hélice un ordre administratif lui ayant interdit d'en user dans l'interieur du bassin du commerce.

'Quoi qu'il en soit après avoir affectué quelques évolutions en différents sens et à des profondeurs variables, le 'Goubet' vient se placer étant au ras de l'eau, à moins de 1 mètre de la rangée des torpilleurs et perpendiculairement à leur axe.

'En cet endroit la profondeur est de 6 mètres d'eau les torpilleurs calent environ 1m. 50 il reste au dessous une hauteur d'eau de 4m. 50. Sans avancer d'une ligne le 'Goubet' s'immerge alors lentement jusqu'au moment où il a atteint la profondeur nécessaire pour pouvoir passer librement sous les bateaux au mouillage c'est à dire jusqu' à environ 3 mètres de la surface du bassin; alors évitant les chaînes des ancres retenant les torpilleurs il franchit assez vivement les 15 mètres qu'occupent les cinq bâteaux rangés bord à bord, et son passage accompli remonte doucement. Il effectue ensuite un virage complet dans un espace moindre que sa longeur

1 'Genie Civil.' G. Vitoux, April, 1890.

c'est-à-dire moindre que 5 mètres et obliquant légèrement en se tenant immergé jusqu'au ras de l'eau il vient passer entre le chaîne d'amarre de l'un des torpilleurs et l'avant de ce bâtiment c'est-à-dire dans une espace à peine large de quelques mètres puis changeant une nouvelle fois de direction il vient border doucement le steamer anglais 'St. Margaret' comme s'il eût dû déposer une torpille le long de ses flancs et enfin il s'éloigne et regagne son porte d'attache.

'L'immersion totale du bateau a été d'environ quarante-cinq minutes.

'Deuxième série d'expériences. Les autres expériences ont encore eu lieu dans le bassin de commerce mais à une petite distance de l' endroit où avaient été faites les premières vis à vis de l'hôtel de l'Amirauté.

'Le radeau remorqué au milieu du bassin ètait fixé par quatre ancres. Sur sa face regardant le quai ouest du bassin une hélice mouillée étant entièrement libre.

'Sur le côté du radeau dirigé vers la mer une perche mobile surmountée d'un drapeau, et qu'un système de contrepoids tendait à maintenir dressée fut abaisée dans l'eau et maintenue dans cette position au moyen d'un lest attaché par un fil.

'Enfin de distance en distance dans le bassin environ à 50 mètres les unes des autres plusieurs petites bouées temoins furent immergées par le même procedé. La position de certains de ces bouées était indiquée par de petits drapeaux qui venaient affleurer à la surface d'autres au contraire étaient entièrement enfoncées au dessous de la surface.

'Cette fois à la suite de la marée l'eau limpide de matin était devenue trouble et noirâtre.

'Cependant les choses étant aussi disposées le bâteau 'Goubet' qui était demeuré dans le fond du bassin arrive signalant uniquement sa presense aux spectateurs par le point formé par l'extremité de son tube optique que l'on voyait émerger de temps à autre.

'Tout d'abord contournant le radeau le torpilleur coupe avec son sécateur le fil maintenant abaissée la perche mobile que l'on voit brusquement se dresser. Puis continuant sa route il vient audevant de radeau où il dépose entre les bras de l'hélice une longue tige de fer il passe ensuite—évitant sans peine les châines d'amarrage malgré leur rap-

prochement—sous l'eau où il abandonne une fausse torpille de 102 kilogrammes et quittant enfin le radeau il s'en va à la recherche des petites torpilles dont il doit couper les fils.

'Successivement le 'Goubet' se dirige vers chacune d'elles cherchant si bien les fils d'attache qu'il retourne au besoin sur ses pas et recommence son opération s'il n'a pas réussi au premier abord les sectionne avec son sécateur et les bouées devenues libres s'en vont à la dérive. Certaines bordes ont ainsi été mise en liberté le bâteau étant en marche.

'Au cours de ses évolutions des boules de verse pouvant servir à renfermer des dépêches ont été envoyées de l'intérieur du torpilleur sous-marin.

'Après deux heures et demie d'evolutions diverses la dernière des bouées ayant été délivrée de ses attaches le 'Goubet' est enfin remonté à la surface son capot à été ouvert et ses deux hommes d'equipage se sont montrés aussi dispos qu'avant l'expérience.

'C'est à cet instant qu'a en lieu de relévement de l'hélice immergée comme nous avons dit dés le début des évolutions sous l'eau.

'A son immersion chacun a pu voir se dresser entre ses branches la barre de fer déposée par le bâteau 'Goubet' et pour bien montrer combien l'entravement était complet un homme monta sur l'une des palettes et demeura assis immobile sans que son poids fit bouger en aucune manière cette hélice que l'on avait vue avant son immersion tourner autour de son axe sous une simple pression de la main.

'Telles sont minutieusement notées les diverses expériences que le bâteau 'Goubet' à exécutées sous les yeux de la population de Cherbourg.'

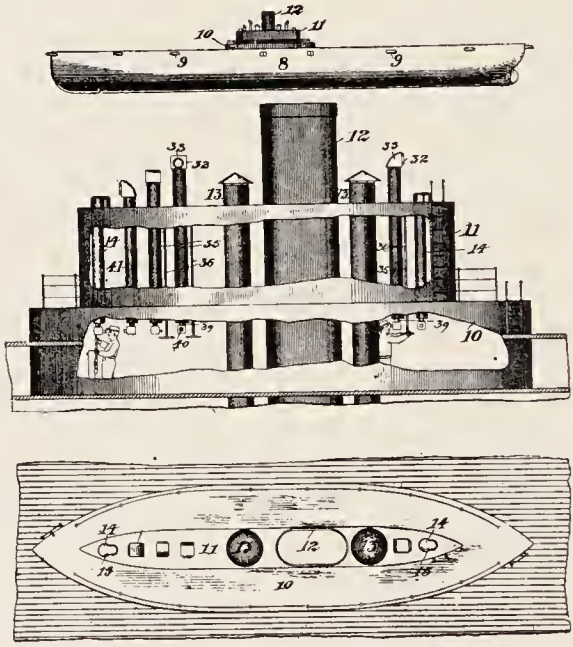
The Gathman Tower.

I have already mentioned Mr. Louis Gathman, of 44, Lincoln Avenue, Chicago, Illinois, but as his invention is of interest, I am giving a detailed description thereof.

To use the words of the inventor 'The object of my invention is to obtain the greatest possible efficiency from the modern compass. With this end in view I obtain for it a

relative freedom from local magnetic influences, and thereby provide a reliable compass particularly for that class of vessels whose hulls can be wholly or partially submerged.

'It is a well-known fact that the compass is subject to great errors and not at all reliable when placed in a submarine vessel below the water line, or when near masses of magnetic metal. I further provide telescopic sights which in combination with my compass give the vessel satisfactory manœuvring capacity. That is to say any desired course can be maintained by the aid of the said compass and the position of an object, —say an enemy's ship—determined by the telescopic sights



CCXLI.-CCXLIII.

while the greater portion or even the entire hull of the vessel is submerged the vessel being thus protected by a body of water and therefore practically secure from the fire of an enemy's guns.

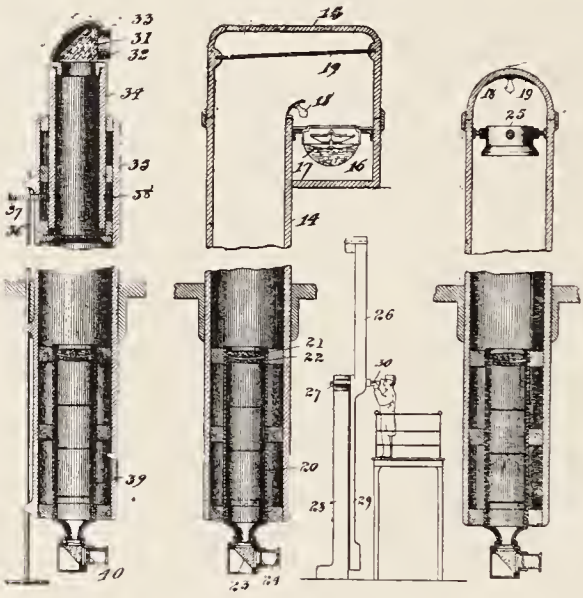
'In the accompanying drawings let 8 represent the hull of a submergible vessel which is provided near the upper deck line with port-holes for the guns 9. The upper deck is surmounted by a conning tower 10 shown in another figure in broken elevation, and this conning tower is surmounted again

by an enclosure 11 protecting and supporting the compasses and telescopic sights, as also the stack 12 and ventilating pipes 13. Arranged preferably near the ends of the conning tower and projecting through the enclosure surmounting it I place my compasses, three forms of which are shown in the drawings. The compass is elevated sufficiently above the deck to be out of the influence of magnetic masses. In order to support the compass in this elevated position, I employ tubes or hollow masts 14 which in the form shown are closed at their upper ends by a cap 15, affording an enlarged lateral chamber 16 within which the compass 17 is mounted.

'In the construction shown in Fig. CCXLV. a binnacle, or modern ship's compass is mounted with a light 18, arranged in proximity thereto, and a reflecting surface such as the mirror 19 extending across the upper portion of the chamber to reflect the reading of the compass down the tube. Within the lower portion of the tube 14 is arranged the telescope, 20 having the ordinary lenses 21, 22, therein or a single lens being provided. At the lower ends of the tube is arranged a prism 23, and adjacent thereto the eye pieces 24; the telescope being of the usual construction, and serving to magnify the image reflected from the mirror, and thus enabling the compass to be easily read by a person stationed in the conning tower, which may be wholly or partially submerged.

'In the construction shown in Fig. CCXLVII. a transparent compass 25 is employed, being mounted within the upper end of a tube and a lamp 18 and reflector 19 are used to assist in the reading; a telescope being arranged in the bottom portion of the tube as in the previously described construction. The form of compass shown in Fig. CCXLVI. is particularly adapted for men-of-war of low free-board and the like class of vessels. This construction is particularly designed to preserve the magnetic centre of a compass on iron ships and to ensure greater steadiness of the compass at sea in all weathers. The compass is placed within a hollow mast or tube 26 which has a journal or trunnion 27 in a supporting post 28 extending up alongside the bridge for convenience. The tube 26 may contain a compass of any approved form, and the said tube is provided, as shown, with a weighted extension 29, depending below the pivotal support

of the tube 26, and serving by its weight to maintain the tube 26 in a perpendicular position, regardless of the pitching or rolling of the vessel. This method of mounting relieves the compass from any excessive motion, and consequent rapid wear of delicate parts, and therefore ensures a steady compass card.



CCXLIV.-CCXLVII.

'In this construction it will be observed that the eye piece 30 is arranged in a line with the axis of the swinging tube, so that such eye piece does not change its position when the tube moves out of alignment with its supporting post.

'As a complement to the compass arrangement above described, and as a part of the equipment of a vessel which is submergible, I employ telescopic sights which enable the guns carried by the vessel to be directed towards any object within range, although the gunner may be practically protected by the submerged part of the vessel. These telescopic sights may be of any desired number, and stationary or capable of revolving as desired. Preferably one or more of them are made so as to be revolved, and thus to sweep the horizon. The telescopic sight comprises a prism 31 mounted opposite a slight aperture 32 in a cap 33, on the

upper end of a tube 34, capable of revolving within the upper end of a supporting tube or cylindrical frame 35 and operated by any suitable means, such as the rod or shaft 36 having the gear wheel or pinion 37 meshing with a rack 38 on the periphery of the tube 34. The supporting tube 35 extends down to the vicinity of the gunner's station, and has mounted in the lower end thereof a telescope 39 with the eye piece 40 accessible to the gunner. The eye piece may be provided with the usual cross lines which are commonly employed in telescopic sights.

'By referring to Fig. CCXLII. it will be seen that I have provided three of such revolving telescopic sights, and have shown a stationary telescopic sight at 41. When a series of these devices are employed, they will preferably project to different heights, and by their duplication or multiplication and also by their varying their heights partial provision is made against the contingency of accident or disabling, which in case only one was employed would leave the ship without adequate means for defence. Furthermore by providing a plurality of these telescopic sights they may be so arranged as to be serviceable for a particular gun or group of guns; the guns being usually stationary or commanding only a certain sweep.

'It will be seen that by means of these inventions a satisfactory manœuvring capacity is given to a submerged or partially submerged war-vessel. When a view of a distant object is obtained by means of the telescopic sights, the bearing of its direction can be maintained by means of the compass as described; even though the vessel and sights and compass be wholly submerged.'

The Cléptoscope.

This instrument is the invention of two Italian Engineers, Signors Russo and Laurenti, and it was recently tested before Signor Morin, the Minister of the Marine, with complete success, and has since been fitted to the 'Delfino.'

This so-called cléptoscope or panoramic périscope gives natural and distinct images, allowing the crew of the sub-

marine to see the horizon from above, as though the eyes were at the upper extremity of the apparatus.

It is practically invisible as only a little tube 5in. in diameter projects from the water, whereas the apparatus measures nearly 20ft. between its extremities.

The cléptoscope which embraces a range of 60 deg. is far in advance of the Maugin-Lauresdat périscope, which is fitted to most of the French submarines. The périscope embraces a maximum of 3 or 4 deg. (?), and gives deformed images, but on the other hand it is not so visible, and therefore less likely to betray the presence of the submarine fitted with it to the enemy. No doubt some efficient means of seeing when submerged will be evolved, but it must be confessed that it is this matter that retards the progress of submarine navigation more than anything else.

V. Direction.

There is not much to be said under this head, the various methods of steering in the vertical sense having been fully explained under the heading 'Stability.' Automatic control of horizontal rudders has not been the subject of much study, its value not being of the greatest; the apparatus invented by the Nourys in the early eighties of the last century has been adequately described in the account of their submarine-boat. It will be remembered that it was thoroughly and successfully tried in the steam pinnace of the old Greek cruiser 'Nauarchos Miaulis' in Phalère harbour.

Another method of steering not yet mentioned is by moveable propellers of the type fitted to the 'Goubet' and early 'Drzewiecki' submarines. This method has never found favour with the authorities, and would not be practicable if applied to large vessels.

VI. Security.

This is obtained in most vessels by the presence of a continual reserve of buoyancy, sufficient, should all other machinery break down, to bring the boat to the surface.

With submarine 'floatability nil' however, another method has to be employed. This is a type of hydrostatic cylinder, which when a too great depth has been reached, effects through the outward pressure, an air-cock which allows a certain quantity of compressed air to enter the ballast tanks, an equal quantity of water being ejected. This method is open to many objections, the first and greatest being that it is as likely to break down as any other portion of a submarine's machinery.

Most submarines have a further means of ensuring a speedy return to the surface, *i.e.*, a detachable safety weight. This is the best and surest guard against drowning or crushing since the sudden detachment of a heavy weight sends the vessel, even if damaged, rushing swiftly upwards.

VII. Habitability.

It is not necessary to recount the various methods of preserving the freshness of the atmosphere when submerged, employed by the many inventors, since they have been explained already in the descriptions of their several inventions.

VIII. Motive Power.

To describe in detail all the types of engines and motors that have been employed for propulsion and working of interior mechanism since the beginning of the submarine would fill many volumes the size of this, which has already far exceeded the proposed limit. Yet it would be impossible to leave the subject altogether without saying a few words about the perhaps most important feature of all submarines. Now one of the most notable facts in connection with submarines is that the power required to impel a vessel through the water is augmented, not diminished, by her submergence. If 5,000 indicated horse-power are required to drive a displacement of 120 tons at 28 knots on the surface, then rather more power will be required to drive 120 tons wholly submerged at the same speed.[1] This may appear strange on the top of what has been said about frictional resistance, but the fact remains.

1 'Engineer,' January 25th, 1901.

SUBMARINE NAVIGATION

There are six methods of propelling a submarine boat.

(a) Electricity.
(b) Oil.
(c) Steam.
(d) Carbonic Acid Gas.
(e) Liquid air.
(f) Hydro-propulsion.

Of these the first two are of the present, the third is of the past, and the last three are of the future.

To start with the third first as being the oldest employed.

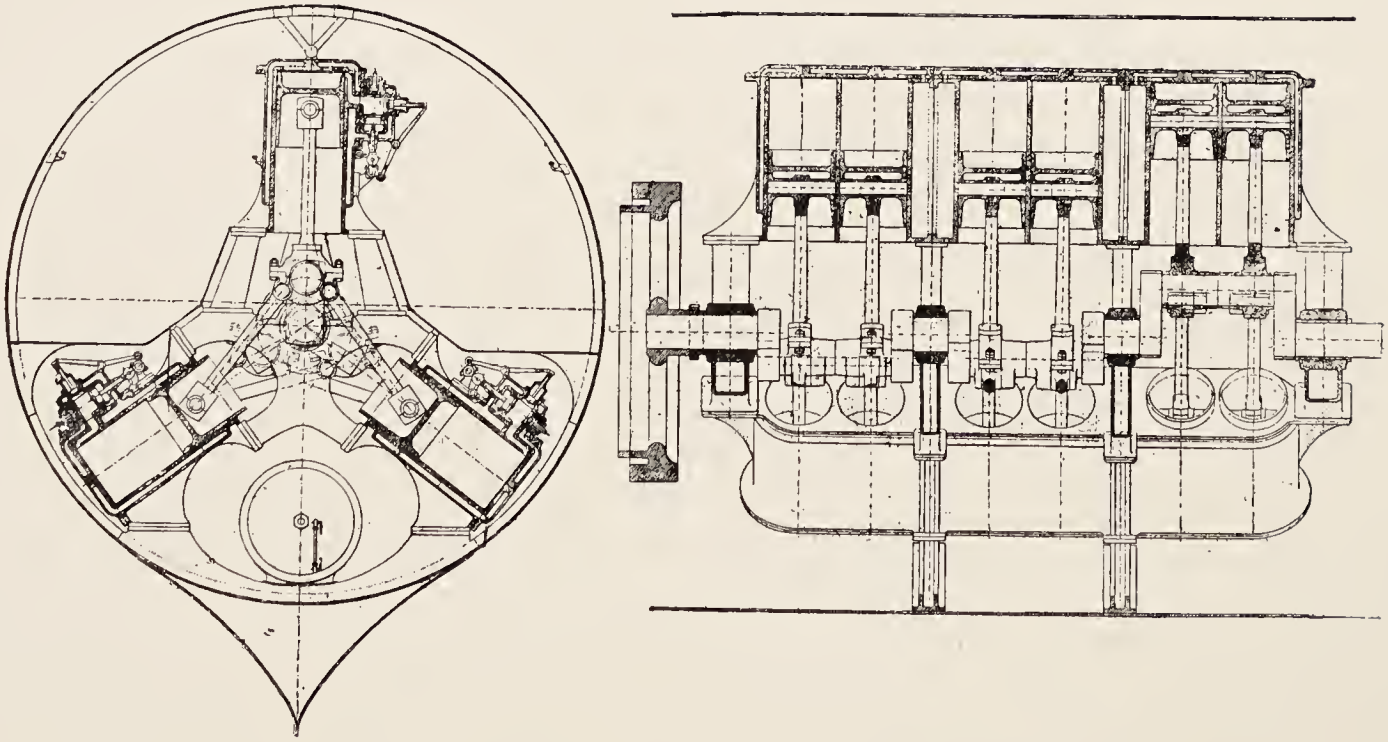
Steam.

Advantages

We will first discuss the advantages and then the disadvantages of steam for submarine navigation. The most prominent and almost the only advantage is the power obtainable and the trustworthy nature of the force used. Steam is now an old friend—is known and understood, which is more than can be said of electricity. Steam, however, like compressed air, exhausts very quickly when the furnace is closed, as witness the trials of the Rev. Garrett's various boats. Another objection is that for the generation of steam, fuel is necessary, and coal or oil must be carried. Then again fresh water is essential and the boiler takes up much valuable space. Of course accumulators are dispensed with in vessels employing solely steam for propulsion, but those using steam for surface work and electricity when submerged, effect no saving.

Disadvantages

A certain well-known engineering paper has set its mind on steam for submarines, and the only reason I can see for this persistence is its noted pessimistic views on the question of submarine navigation. We may be very sure that if steam had advantages sufficient to outweigh its many disadvantages we should not now be employing oil and electricity on our 'Hollands' nor would France, the nation best capable, owing to the years spent in experiment, of knowing what is and what is not the best means of propulsion for submarine boats, continue fitting petrol and electrical machinery to her mosquito



CCXLVIII.-CCXLIX. F. FOREST'S 18-CYLINDER OIL ENGINE

fleet. Dr. Payerne was the first to advocate steam for submarine boats, and since his time experiments of an interesting and instructive nature have been carried out by M. D'Allest, the inventor of the well-known torpedo-boat boiler, the Liquid Fuel Engineering Company and A. Siegle. For submersible craft steam has a future, and the steady advance towards perfecting liquid-fuel furnaces make the time when coal is no longer necessary no great distance off.

Electricity.

The electric motor is daily acquiring a greater power, and a month seldom passes but what a new and improved type of accumulator is put on the market. A few of the best known makers and types of electric motors suitable for submarine boats are:—The General Electric Company Ltd., D. Bruce and Co., The Electrical Co. Ltd., Martin and Co., British Schuckert and Electric Co. Ltd., Brierley, Reckenzaun, Krebs, Sautter-Lemonier, Ayrton and Perry, Thompson, Wheatstone, Bregnet, Luttrès, Dal-Négro, Gramme, Davidson, Page, Siemens, Desprez, Griscom, Hjorth, Jacobi Howe, Ritchié, de Meritens, Stargeon, Trouvé, Wiessendanger. The list might be lengthened three-fold, and yet not be exhausted, so numerous are the firms competing in the race for the best, most powerful and compact motor. Of accumulators I might mention those of Peyrusson, Phénix, Fulmen, Blot and Pollak, although most of the firms mentioned as constructors of motors employ accumulators of their own design.

Motor Makers

Accumulators

I will describe one motor, that of the 'Gymnôte,' and this description must through lack of space suffice for all such machines.

'Gymnôte's' Motor

'Ce moteur est à seize pôles disposés symétriquement autour de l'anneau mobile. Celui-ci à 1 mètre de diamètre; il est muni d'un collecteur à quatre balais, deux pour la marche avant, et deux pour la marche arrière. Son poids est de 2,000 kilogrammes; son travail égale 55 chevaux-vapeur, et son courant de 200 ampères avec une différence aux bornes de 192 volts.

'Le courant électrique étant fourni par une batterie de 564 accumulateurs à liquide alcalin, construits par M. M. Coumm-

lins, Desmazures et Baillache. Ils pèsent chacun 17 kg. 500, soit donc un poids total de 9,870 kilogrammes. Le courant est envoyé dans la machine par la totalité des accumulateurs, groupés de quatre façons différentes au moyen d'un appareil spécial permettant d'obtenir quatre vitesses par la maneuvre d'une seule manivelle.

'1. Petite vitesse, comprenant 12 accumulateurs en surface et 47 en tension.

'2. Moyenne vitesse, comprenant 6 accumulateurs en surface et 94 en tension.

'3. Vitesse de route, comprenant 4 accumulateurs en surface et 141 en tension.

'4. Grande vitesse, comprenant 2 accumulateurs en surface et 282 en tension.

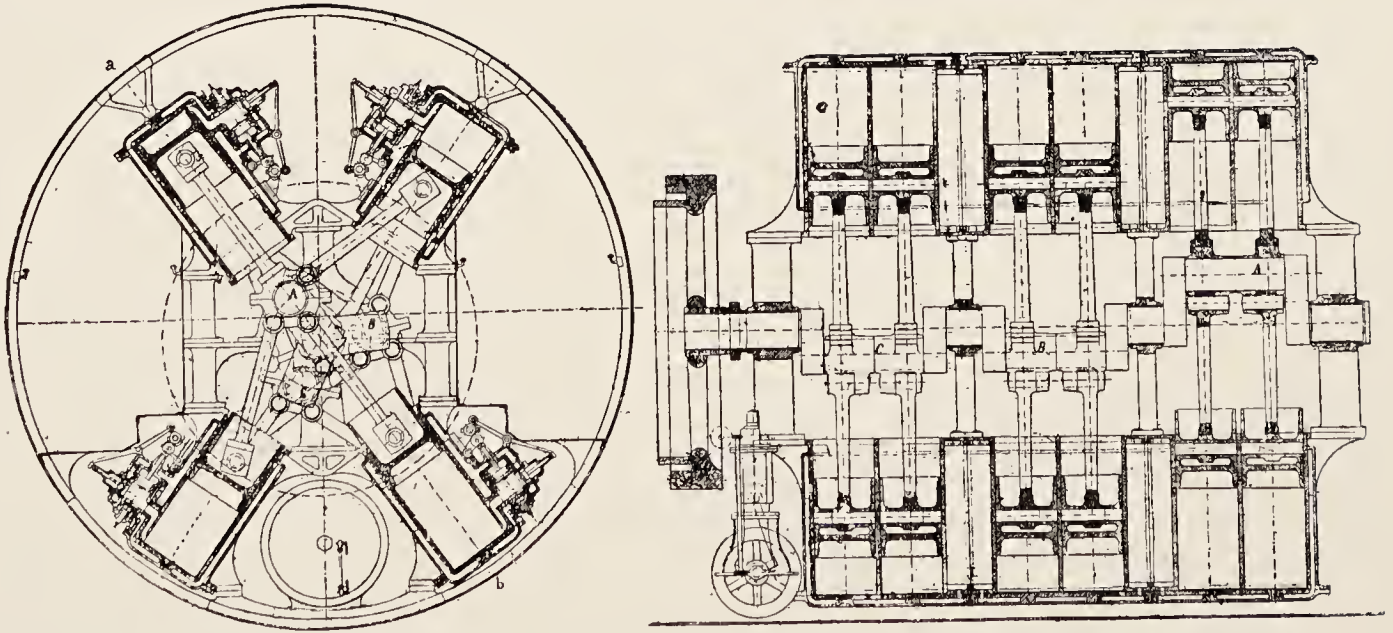
'La Commission du Ministre de la Marine, chargée de recevoir la partie électrique du 'Gymnôte,' le 16 mars 1883 dans les ateliers de la Société des Forges et Chantiers de la Méditerranée, au Havre, a procédé aux essais suivants.

'Les accumulateurs ont été chargés, en prenant le troisième groupement, par un courant de 100 ampères, nécessitant une force électromotrice égale a 140 volts. La durée de la chargé à été vingt-trois heures; la force électromotrice a varié de 135 (au commencement) à 144 volts (à la fin.)

'La capacité totale de chaque accumulateur résultant du poids de zinc contenu dans l'appareil est de 520 ampères-heures; la charge en a fourni 575. Il faut dire que la batterie était neuve; il a fallu depenser une certaine quantité d'électricité pour la former; c'est ce qui explique cette augmentation.

'La décharge s'est operée avec le quatrième groupement en quatre heures et demie, avec un travail, aux bornes de la machines, de 58 chevaux-vapeur pendant les trois premières heures (206 ampères et 208 volts), de 54 chevaux pendant la quatriéme (200 ampères et 200 volts), et 47 chevaux à la fin des quatre heures et demie (190 ampères et 182 volts). Mais une vingtaine d'accumulateurs s'étaient déchargés eux-mêmes par suite d'un isolement insuffisant. L'utilisation a donc été de 450/520 9865 de la capacité totale des accumulateurs.

'Le poids d'accumulateurs (vase et liquide compris) est donc, par cheval-heure recueilli de 37 kilogrammes.



CCL.-CCLI. F. FOREST'S 24-CYLINDER OIL ENGINE

'La vitesse du moteur électrique est de 280 tours à la minute, avec un courant de 200 à 210 ampères, et sa resistance de 0 ohm, 16.[1]

Oil.

The oil engine has come more and more to the front as the popularity of the motor-car increased, and the desire to obtain the maximum of power in the minimum of space is a step towards obtaining an efficient oil engine for submarine boats. The Otto gas engine is perhaps the best known of this type in connection with submarine navigation, its reliability being remarkable. It does however tend to produce transversal oscillation, and the system adopted by M. Forest, the greatest exponent of the oil engine for submarine boats, seems to me the best. In it M. Forest places several cylinders on lines radiating from the central shaft on to which all the pistons play. These cylinders are equidistant one from the other round a circle drawn within the contour of the hull and hence the force exerted is equally distributed, the oscillation of the crank of one being counteracted by the obverse movement of the crank of another. On the opposite page is a plate illustrative of two types of Forest Engine. The first is an 18 cylinder engine, with the cylinders placed in three groups of six in a triangle, and the second illustrates a 24 cylinder engine, with the cylinders placed in four groups of six in a quadrilateral figure. These are both engines of 500 I.H.P., and in the plans of my submersible armoured torpedo-boat, I have placed an 18 cylinder Forest engine. As however in this case the 12 cylinders are above the centre of buoyancy and 6 below, it might perhaps be preferable to have a 24 cylinder engine instead, in which case the weight would be evenly distributed. I do not think however that the method I have adopted militates to any great extent against stability, the electric motor and accumulators more than compensating for the awkward placing of the engines. These engines it will be noticed have a gangway on either side and this, in a space so confined as the interior of a submarine boat, is a matter of some moment.

Otto Gas Engine

F. Forest's Engine

The Two Types

Advantages

1 Communication de L'Académie des Sciences.

Various Types Disadvantages

Other well-known types of oil-engines are:—Diesel, Monarch Motor Co., Forward Engineering Co. Ltd., Crossley, Daimler, Tangyes. The one objection to oil engines is their habit of giving off fumes. It must be remembered that the supply of air below is very limited, and great care must be taken not to spoil it with petroleum vapour, which may easily become not only intolerable to the senses, but excessively dangerous in a confined space. This fault is not irremediable however, and no complaint is heard from the crews of the 'Holland' boats, so we may presume the inconvenience suffered, if any, is slight.

Carbonic Acid Gas.

Many attempts have been made to construct an engine which can be worked by liquid carbonic acid. The general result has hitherto been that the inventors have been more or less broken up in body and mind. When there is a carbonic anhydride engine in existence it will be time enough to speculate as to its fitness for submarine work.

Liquid Air.

An unknown quantity, difficult to manufacture, and still more difficult to store when obtained. I know intimately an American who made several trips on a motor-car run by liquid air (New York, 1900), but the Inventor never succeeded in going more than 20 miles without the machinery clogging. This does not sound very hopeful for submarine boats, but there is one advantage which would be attached to its use, *i.e.*, it would keep up the supply of oxygen required by the crew.

Hydro-Propulsion.

A Weak Method

This method, proposed by Sir G. Strickland, is scarcely worthy of comment. It is practicable enough, but is lacking in efficiency. Surface vessels fitted in this way (I have seen

a small hydro-propelled steam launch in Paris) have never exceeded a speed of 10 knots, and this with a power out of all proportion to the speed obtained.

Propulsion by High Explosives

There are one or two other methods worth noting, but not worth detailing, namely, compressed air and high explosives. Olivier desired to propel his boat in the same manner as a rocket, but he would in all probability have blown himself and his vessel into the next world, had he put his theory into practice. Bourgeois and Brun used compressed air, but the power fell so rapidly to nil that their efficacy is questionable. It seems, therefore, as though we had now to wait on the good offices of our mechanicians for a sure and powerful mode of propulsion.

Propulsion by Compressed Air

Future Developments

It may be that some new form of concentrated energy will be obtained in the future, but I fancy the inventor would find its employment far more remunerative on shore than under the sea; likewise such inventors would do well to bear in mind that concentrated energy is a very awkward thing to deal with. Nitro-glycerine, for example (to say nothing of fulminate of mercury, dynamite, mélinite and maximite), represents a good deal of concentrated energy. Yet it would require a real madman to attempt to turn either of these into motive power, for any energy so obtained would be liable to prove decidedly unpleasant for the originator.

IX. Armament.

History of Gunpowder

No invention of man ever created so great a change in warfare, and consequently in the destinies of nations, as the combination of the ingredients which compose gunpowder. Writers upon engines of war have ascribed the origin of the invention to various periods of history, and to different nations. But it would appear that, although the compound had been rudely manufactured by Arabs and Chinese (by the latter, it is said, 3,000 B.C.), to astonish and delight the curious, and frighten and impress the superstitious, the discovery was not promulgated in Europe until the middle of the 13th century, when Bacon declared that with 'saltpetre, charcoal and sulphur, one could make thunder and lightning if he knew the

art.' Certain it is that what to the Crusaders was known as 'Greek Fire' was some imperfect combination of nitre and sulphur; and that as far back as the 7th century the rulers of the Byzantine Empire were acquainted with an incendiary substance of an extraordinary character, the composition of which was ordered to be kept as a State secret, and was so kept until the beginning of the 13th century. Then the secret escaped to the Arabs, and the substance was used by them to terrify the superstitious Crusaders, who resorted to prayers and supplications to avoid its effects, and spread throughout the world exaggerated accounts of its terrors. It was not, however, until the commencement of the 14th century[1] that gunpowder was employed as an agent for throwing balls and stones. Although its explosive character was then known to monks and students of Christian Nations, the Arabs were the first to avail themselves of its advantages in their wars with the Spaniards, and from Spain its use spread to the other countries of Europe. Still circumstances tended to check, rather than to develop the improvement of fire-arms and artillery for a long period after the invention of gunpowder became generally known.

Public Sentiment Hostile to Gunpowder

The same sentimentality which in the early seventies, denounced the use of torpedoes as contrary to humanity, prevailed to some extent with reference to gunpowder, and there was a general aversion to the newly invented arms, as calculated to extinguish personal bravery. Thus does history repeat itself, for where more than five centuries ago the 'gun' was shunned as an innovation; to-day the submarine boat is the recipient of an equal measure of public denunciation, and so also in years to come, the aerostat, aeroplane and dirigeable war-balloon will at their *naissance* as practical units of warfare be received with cries of horror as controverting all laws of humanity and fellow-feeling. This petty quibbling, however, can only retard and not suppress the airship, which will take its place amongst the weapons of combat in the same way as gunpowder, the ironclad and the torpedo have done, and the submarine boat is doing. Not three years ago it was difficult

1 John Barbour, Archdeacon of Aberdeen, wrote in 1375 that Edward III. employed what he called 'crakys of war' in the invasion of Scotland, 1327.

to find anyone who could talk about submarine vessels without treating them as a joke, and to-day—*que voulez vous (?) tout cela change!* but unfortunately in the matter of new inventions *experientia non docet*, and so it always will be.

Lack of Mechanical Skill

But to return to gunpowder. There was, on its adoption, a great lack of mechanical skill necessary to adapt this new agent to purposes of war. Iron and brass were, during the 14th century, costly and scarce; great difficulties were encountered in working them, and in making guns sufficiently strong to stand the explosion of even the powder of that day. Saltpetre and sulphur were also rare and expensive materials. They could only be obtained in small quantities, at great expense and labour. However, in this invention, as in all arts and sciences, progress was made. Schwartz, discovered that the granulation of powder increased the force of explosion and soon cannon and small arms figured in every siege and battle. From this time the use and quality of gunpowder steadily increased and improved, pitched battles became rare, and when they did take place, were of the bloodiest; yet no cry on the plea of humanity was raised, for the world had grown accustomed to explosives, and had decided that self-defence is the first law of nature, and the first duty of nations! It is unnecessary for me to trace the steady progress of improvement in arms and engines of war resulting from the discovery of gunpowder. The mechanical genius of each generation has been constantly directed to the subject, and has left behind it vastly improved cannon and small arms.

Discovery of Schwartz

Derivation of Word 'Torpedo'

Of all the inventions by which gunpowder has been adapted to war, the torpedo is perhaps the most destructive and terrible in its immediate effects when successfully employed, either as a mode of attack upon ships or defence against their operations. The term 'torpedo' is the popular name of the electric 'ray' or 'skate' of the family 'torpedinidae.' It was called ναρκη by the Greeks, and 'torpedo' by the Romans. The Germans call it 'krampf-fisch,' the French 'torpille' and the Arabs 'raad' or lightning. This is not the only fish possessed of these powers of communicating shocks, there being four species, amongst which I may mention the 'Gymnotus' or Surinam electric eel, after which the invention of the late M. Gustave Zédé is named.

SUBMARINE NAVIGATION

History of the Torpedo

Until the war with this country which secured the independence of the United States, military history furnishes no direct evidence that the machine now designated 'torpedo' was ever employed as an engine of war, although nearly allied in its operation to the system of mining which followed closely upon the discovery of gunpowder. To David Bushnell, of Connecticut, is justly attributed the idea of attacking a ship by applying to its submerged parts a magazine of powder, which when exploded by devices contrived for the purpose, should disable or destroy her. The following is a description of Bushnell's torpedo.[1]

Bushnell

Description of a magazine and its appendages to be conveyed by the submarine vessel[2] to the bottom of a ship.

'In the fore part of the brim of the crown of the vessel was a socket, and an iron tube passing through the socket; the tube stood upright, and could slide up and down six inches. At the top of the tube was a wood-screw fixed by means of a rod, which passed through the tube and screwed the wood-screw fast upon the top of the tube. By pushing the wood-screw up against the bottom of a ship, and turning it at the same time, it would enter the planks. When the wood-screw was firmly fixed, it could be cast off by unscrewing the rod which fastened it upon the top of the tube.

'Behind the vessel was a place, above the rudder, for carrying a large powder magazine. This was made of two pieces of oak timber, large enough, when hollowed out, to contain an hundred and fifty pounds of powder, with the apparatus used in firing it. A rope extended from the magazine to the wood-screw above mentioned; when the wood-screw was fixed, and to be cast off from its tube, the magazine was to be cast off likewise, leaving it hanging to the wood-screw. It was lighter than water, that it might rise up against the object to which the screw and itself were fastened.

'Within the magazine was a clock, constructed to run any

1 From a paper read by Bushnell before the American Philosophical Society, June 8th, 1798.

2 See Bushnell's invention in the historical part.

proposed length of time under twelve hours; when it had run out its time, it unpinioned a strong lock, resembling a gun lock, which gave fire to the powder. This apparatus was so pinioned that it could not possibly move till, by casting off the magazine from the vessel, it was set in motion.

'The skilful operator could swim so low on the surface as to approach very near a ship in the night without fear of being discovered, and might, if he chose, approach the stem or stern with very little danger. He could sink very quickly, keep at any necessary depth, and row[1] a great distance in any direction he desired without coming to the surface. When he rose to the surface he could soon obtain a fresh supply of air, and, if necessary, he might then descend again and pursue his course.'

Experiments made to prove the nature and use of a submarine vessel.

'The first experiment I made was with about two ounces of powder, which I exploded four feet under water, to prove to some of the first personages in Connecticut that powder would take fire under water.

'The second experiment was made with two pounds of powder, enclosed in a wooden bottle, and fired under a hogshead, with a two-inch oak plank between the hogshead and the powder; the hogshead was loaded with stones as deep as it could swim. A wooden pipe, descending through the lower head of the hogshead and through the plank into the powder contained in the bottle, was primed with powder. A match put to the priming exploded the powder, with very great effect, rending the plank into pieces, demolishing the hogshead and casting the stones and ruins of the hogshead, with a body of water many feet into the air, to the astonishment of the spectators. This experiment was like-wise made for the satisfaction of the gentlemen above mentioned.

'I afterwards made many experiments of a similar nature, some with large quantities of powder.

'In the first essays with the submarine vessels, I took care

1 This seems to confirm my opinion that Bushnell's 'Turtle' was fitted with oars and not with screws.

to prove its strength to sustain the great pressure of the incumbent water, when sunk deep, before I trusted any person to descend much below the surface; and I never suffered any person to go under water without having a strong piece of rigging made fast to it, until I found him well acquainted with the operations necessary for his safety. After that I made him descend and continue at particular depths without rising or sinking; row by the compass; approach a vessel; go under her and fix the wood screw into her bottom, etc., until I thought him sufficiently expert to put my designs into execution; I found, agreeably to my expectations, that it required many trials to make a person of common ingenuity a skilful operator. The first [1] I employed was very ingenious, and made himself master of the business, but was taken sick in the campaign of 1776, at New York, before he had an opportunity to make use of his skill, and never recovered his health sufficiently afterwards.

'After various attempts to find an operator to my wish, I sent one,[2] who appeared more expert than the rest from New York, to a fifty-gun [3] ship lying near Governor's Island. [4] He went under the ship and attempted to fasten a wood-screw into her bottom, but struck as he supposes a bar of iron.[5] Not being well skilled in the management of the vessel in attempting to move to another place, he lost the ship, and after seeking her in vain for some time he rowed some distance and rose to the surface of the water, but found daylight had advanced so far, that he durst not renew the attempt. On his return from the ship to New York, he passed near Governor's Island and thought he was discovered by the enemy; he cast off the

1 According to Thacker's Mil. Journal, p. 63, this person was Mr. Ezra Bushnell, brother of the inventor.

2 Sergeant Ezra Lee (Silliman's Journal Vol. II., No. 1, pp. 95-100, April, 1820). It is strange that the two christian names should be Ezra. This coincidence has led to many errors re Bushnell's boat.

3 This is undoubtedly a mistake. The ship was the 'Eagle,' of 64 guns, commanded by Captain Henry Duncan, and bearing Lord Howe's flag. She entered the anchorage on July 12th, 1776 ('The Royal Navy,' W. Laird Clowes, Vol. III., pp. 380-400), and was attacked a few nights later. (Allen's American Biog. Dict., 3rd edit., 1857.)

4 Staten Island, according to other authorities. The two are close together.

5 The 'Eagle's' bottom was coppered. (Thacker's Mil. Journal, 1817.)

magazine as he imagined it retarded him in the swell, which was very considerable. [1]

'After it had been cast off one hour, the time the internal apparatus was set to run it blew up with great violence.

'Afterwards, there were two attempts made in Hudson River, above the City, but they effected nothing. Soon after this the enemy went up the river, and pursued the vessel which had the submarine boat on board, and sunk it with their shot. Though I afterwards recovered the vessel, I found it impossible to prosecute the design any further. I had been in a bad state of health from the beginning of my undertaking, and was now very ill. The situation of public affairs, was such, that I despaired of obtaining the public attention and assistance necessary. I therefore gave over the pursuit for that time and waited for a more favourable opportunity, which never arrived.

'In the year 1777, I made an attempt from a whale-boat against the 'Cerberus'[2] frigate, then lying at anchor between Connecticut river and New London, by throwing a machine against her side by means of a line. The machine was loaded with powder to be exploded by a gun-lock, which was to be unpinioned by an apparatus, to be turned by being brought alongside of the frigate. This machine fell in with a schooner at anchor astern of the frigate, and concealed from my sight. By some means or other it was fired, and demolished the schooner and three men, and blew the only one left alive overboard, who was taken up very much hurt.'[3]

1 For a detailed account of this adventure see Silliman's Journal, April, 1820, pp. 95-100, where will be found the statement of the operator, Mr. Ezra Lee, taken from him by Mr. Griswold, and communicated to the journal by him.

2 The 'Cerberus,' 32 guns, Captain Sir Jacob Wheate, Bart., was wrecked near Bermuda in 1783.

3 The following extract from a letter of Commodore Symons to Rear-Admiral Sir Peter Parker, dated August 15th, 1777, is interesting:—

'Wednesday night, being at anchor to the westward of New London in Black Point Bay, the schooner I had taken at anchor close by me, astern, about eleven o'clock at night we discovered a line towing astern that came from the bows; we immediately conjectured that it was somebody that had veered himself away by it, and began to haul in; we then found that the schooner had got hold of it (who had taken it for a fishing line), gathered in nearly fifteen fathom, which was buoyed up by little bits of sticks at stated distances, until he came to the end, at which was fastened a machine, which was too heavy for one man to haul up,

I have quoted Bushnell's inventions at some length since, being the originator of torpedo warfare, his experiments are of especial interest. Bushnell's work was carried on several years later by Fulton, whose inventions I have already described in some detail, and which space does not permit me to recount. His torpedo was less primitive than that of Bushnell, being made of metal. In 1805 Gillot discovered the value of electric ignition, and strange as it may appear, absolutely no notice was taken of his invention, despite the enormous effect it was destined to have on future coast defence warfare. A few years later Duane published a work on torpedoes, and attack by means of high explosives, whilst simultaneously with the appearance of this work Parizot, a captain in the artillery made experiments with a dormant torpedo for coast defence.[1] We next hear of torpedoes in Russia, several interesting experiments being carried out with explosive bombs designed by Colonel Firzow during the years 1813-19. The results were, so we are told, very satisfactory. In 1815 came propositions by Barnes, and during the same year, a pamphlet was published on the subject by Gassendi. In 1819, as has already been chronicled earlier in this work, Montgery gave to the world his valuable treatise on submarine

Fulton

1805 Gillot

Duane

Captain Parizot

1813—19 Col. Firzow

1815 Barnes

Gassendi

1819 Montgery

being upwards of 100 cwt. (?), the other people of the boat turning out assisted him, got it upon deck, and were unfortunately examining it too curiously when it went off like the sound of a gun, blew the boat to pieces, and set her in a flame, killed the three men that were in the stern; the fourth, who was standing forward, was blown into the water. I hoisted out the boat, and picked him up much hurt. As soon as he could recollect himself he gave me the following description, as near as he could remember:—It was two vessels shaped like a boat, about twenty inches long, and a foot broad, secured to each other at the distance of four feet by two iron bars, one at each end, and an iron tube or gun-barrel in the centre, which was loose (as he had himself turned it round with his hand); they swam one over the other, the upper one keel upwards; the lower swam properly, but was so under water as just to keep the upper one a few inches above the surface; to the after iron bar hung a flat board, to which was fixed a wheel about six inches in diameter, and communicated itself to one on the upper side of the boat, of a lesser diameter. Opposite to these was another wheel, on the flat of the under one or loaded vessel, which had likewise communication with the wheels of the upper boat; it was covered with lead, and the keel heavily loaded in order to keep it down in the water.

'The fatal curiosity of the seamen set this wheel agoing, and during their looking at it, which was about five minutes from the time of its being first put in motion, it burst.'

1 The original model of Captain Parizot's torpedo is in the Invalides at Paris.

warfare, with his able criticisms on Fulton's experiments. Three years later Cotty produced a work devoted to the subject, and in 1823 appeared several interesting articles in the 'Annales Maritimes.' In 1829 Colonel Samuel Colt, although but a boy in years, commenced a series of experiments with torpedoes that excited the attention of older and more experienced heads. It seems that Colonel Colt's pet idea was not the revolver, but rather his submarine battery,[1] and he laboured unwearingly from the time above mentioned up to the year 1845; as he wrote to President Tyler, 'I have employed my leisure in study and experiment to perfect the invention of which I now consider myself master.'[2]

1822 Cotty
1823 'Annales Maritimes'
1829 Col. Colt

'His earnings had been swallowed up in abortive arm factories,' says his biographer,[3] and he therefore solicited Government aid for trying submarine experiments, which were beyond his private means, and which, if successful, were sure of redounding to the public good.'

It was asserted that Colt could ignite a destructive shell under water at a distance of ten miles, in a few seconds, its principle being founded on the electric fluid.[4] On the 4th of June, 1842, he exploded a torpedo in New York Harbour with a galvanic battery, and on July 4th, of the same year completely destroyed the old gun-boat 'Boxer.' On the 18th of October, 1842, the brig 'Volta' of 300 tons, was blown up in New York by Colonel Colt's battery. This experiment was conducted under the patronage of the American Institute, and was witnessed by 40,000 spectators.[5]

1842 Colt's 'Boxer' Experiment 'Volta'

Lieutenant Fabien, of the French Navy, took up in 1831 the experiments of Gillot, prematurely ended by the death of the latter.

1831 Lieut. Fabien

The same year Mr. Moses Shaw, of New York, and Dr. Hare, of Philadelphia, discovered simultaneously a method of electric ignition, and at once constructed torpedoes to prove the utility of their inventions. In 1837 Chevalier Lemelt

M. Shaw
Dr. Hare
1837 Chevalier Lemelt

1 'Submarine Warfare,' by Lieut.-Commander J. S. Barnes, U.S.N., 1869, p. 53.

2 Letter from Col. Colt to President Tyler, dated Washington, June 19th, 1841.

3 Rev. Dr. Barnard.

4 'New York Herald,' March 17th, 1842.

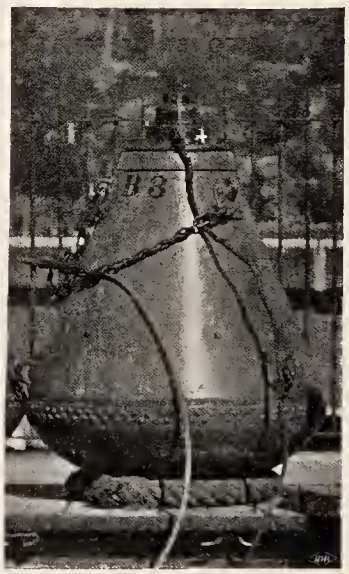
5 'New York Tribune.'

1839 Col. Pasley Destruction of 'Royal George'

advocated the use of an explosive mine for destroying rocks in fair-ways; this machine be called a 'fulminifère.' Two years later Colonel Pasley destroyed the remains of the 'Royal George,' sunk at Spithead in 1789, by means of an electric mine.

1844 The 'Warner' Experiments

In 1844, a Mr. Warner, produced a great sensation by an invention which appears to have been essentially a floating torpedo. He exploded a torpedo under a barque from the deck of a steamer 300 yards away from the target; this



By favour of the 'Navy and Army Illustrated.'

CCLII. A SUBMARINE MINE

experiment was made off Brighton before a large concourse of people.[1] During the Crimean War the Russians employed numbers of mines for the defence of Cronstadt and Sebastopol. These torpedoes were 'the conception and idea

Prof. Jacobi

of Professor Jacobi, an eminent Russian chemist and philosopher.'[2] During the construction of the Cherbourg defences 50,000 cubic metres of rock were blown to pieces at one time, by the simultaneous explosion of six electric mines designed

1 'Discoveries and Inventions of the Nineteenth Century.' R. Routledge, F.C.S., p. 181.

2 'Art of War in Europe.' General Delafield.

by M. du Moncel, and in 1854 Lieutenant-Colonel Hennebert presented to the French Government the models of two torpedoes, one dormant and the other dirigible.[1] The use of torpedoes during the American war of Secession, and the destruction of the 'Tecumseh' are too much matters of history to require recounting. It is worthy of note that during this war no fewer than twenty-eight vessels were blown up by mines, and six by various forms of torpedoes.[2] Before the American war had been over a year, that which by some has been described as the greatest discovery of the age, was invented—the Whitehead torpedo.

M.du Moncel
1854
Lieut.-Col.
Hennebert
Destruction
of
'Tecumseh'

Floating and Towing Torpedoes.

Before proceeding to a description of the automobile torpedoes, I would like to mention a class of weapon of which a great deal was thought thirty-five years ago. These are the floating and towing torpedoes. The first we hear of are those of Bushnell, these were kegs of powder supported by small floats and set down the tide to destroy the British Shipping. The following account of the incident is worth recording.[3]

Bushnell

'Among the amusing and facetious incidents of the war, which sometimes cheered the heart amidst its abiding gloom, was that of the celebrated occurrence of the 'Battle of the Kegs' at Philadelphia. It began at early morn, a subject of general alarm and consternation, but at last subsided in matter of much merry-making amongst our American Whigs, and of vexation and disappointment on the part of the British. When the alarm of explosion first occurred the whole city was set in commotion. The housekeepers and children ran to their houses generally for shelter, and the British everywhere ran from their shelters to their assigned places of muster. Horns, drums and trumpets sounded every-

'Battle of
the Kegs'

1 'Les Torpilles Automobiles.' Ed. Bara and H. Noalhat.

2 'Torpedoes and Torpedo Vessels.' Lieut. G. E. Armstrong, late R.N., p. 2.

3 From 'The Annals of Philadelphia and Pennsylvania,' 1844, Vol. II., pp. 335-336.

where 'to arms' with appalling noise, and cavalry and horsemen dashed to and fro in gay confusion.

'The kegs which gave this dire alarm were constructed at Bordentown, and floated down the Delaware for the purpose of destroying the British Shipping, which lay out in the stream, moored in a long line, the whole length of the city. The kegs were charged with gun-powder, and were to be fired and exploded by a spring-lock, the moment the kegs should brush against the vessel's bottom. The kegs themselves could not be seen—being under water; but the buoys which floated them were visible. It so happened, however, that at the very time (on January 7th, 1778) when the scheme was set in operation, the British, fearing the making of ice, had warped in their ships to the wharves, and so escaped much of the intended mischief. The crew of a barge attempting to take one of them up, it exploded and killed four of the hands and wounded the rest. Soon all the wharves and shipping were lined with soldiers. Conjecture was vague, and imagination supplied many 'phantoms dire.' Some asserted the kegs were filled with armed rebels, that they had seen the points of their bayonets sticking out of the bung-holes. Others, that they were filled with inveterate combustibles, which would set the Delaware in flame and consume all the shipping. Others deemed them magic machines which would mount the wharves and roll all flaming into the city! Great were the exertions of officers and men, and incessant were the firings, so that not a chip or stick escaped their vigilance. We are indebted to the facetious muse of Francis Hopkinson, Esq.,[1] for the following jeu d'esprit upon the occasion. I give an extract:—

Those kegs I'm told the rebels hold,
  Packed up like Pickled Herring;
And they've come down to attack the town,
  In this new way of ferrying.

The soldiers flew, the sailors too,
  And, scared almost to death, sir,
Wore out their shoes, and spread the news,
  And ran till out of breath, sir.

1 The son of this Mr. Hopkinson composed the American National song 'Hail, Columbia'; also 'Columbians all this present hour.'

'Arise, arise!' Sir Erskine cries;
'The rebels, more's the pity
Without a boat, are all afloat
And ranged before the City.'

The royal band now ready stand,
All ranged in dread array, sir,
With stomach stout to see it out,
And make a bloody day, sir.

Such feats did they perform that day,
Amongst those wicked kegs, sir,
That years to come, when they get home,
They'll make their boast and brag, sir.

Lewis' torpedo was especially designed for floating down on to and destroying obstructions, such as chains, wooden booms, and indeed every type of floating device that might be applied to the defence of a ship or harbour. The next torpedo of this type was the invention of MacEvoy, a trifle more complicated than that of Lewis, which was nothing but a piece of wood supporting a powerful charge. Ericsson, also provided the American Navy with a floating torpedo, but its success was very mediocre. Of the towing torpedoes only two are worthy of mention. That of Commander Harvey is the best known. This torpedo has some remote resemblance to a boat, though constructed with flat surfaces throughout. The outside case was formed with wood, well bound with iron, all the joints being made thoroughly watertight. The dimensions were: length, 5ft.; depth, 1¾ft.; breadth, 6in. Within this wooden case is another watertight case made of thick sheet copper, from the top of which project two very short wide tubes. These are the apertures through which the explosive material is introduced, after which the apertures are securely stoppered down. The towrope was so arranged on it that it did not follow in the wake of the vessel to which it was attached, but diverged at an angle of 45 degrees. Very similar was the invention of Commander Menzing, of the German Navy, except that by his system, a torpedo could be towed on either side of a vessel, and thus a warship so armed, steaming between two hostile ships close together, might conceivably destroy both.

Lewis' Torpedo

MacEvoy

Ericsson

Com. Harvey

Com. Menzing

The Whitehead Torpedo.[1]

Origin of the 'Whitehead'

Capt. Lupuis' Idea

The origin of the Whitehead torpedo was due to the enterprise of a Captain Lupuis, of the Austrian Navy, who desired to discover a means of propelling a small floating torpedo along the surface of the water, and directing it by means of ropes from a fixed base. His idea was to charge the forward end of the little fireship with gunpowder and to explode the charge by releasing a pistol on contact. On laying his plans before his Government, he was informed that in the opinion of the authorities the suggestion was unworkable unless he could discover some really reliable form of independent motor. Undaunted by his want of success, Captain Lupuis sought aid, and found the most efficient help in a Mr. Whitehead, manager to an engine manufacturing company at Fiume. The ideas of Captain Lupuis, although crude in themselves, were sufficiently promising to attract the attention of Mr. Whitehead, and he at once set about designing a torpedo which, although on the principle of that devised by the Austrian officer, differed from it in almost every particular. It was not long before he discovered that a locomotive torpedo which travelled on the surface of the water, and was guided from the ship or the shore by ropes, was eminently unpractical, or at any rate that such a machine would only possess a very limited sphere of usefulness Accordingly he abandoned Captain Lupuis's plans and set about to discover whether it was not possible to devise a torpedo which would be entirely independent of outside aid when once it had been started on its course, and which possessed the additional advantage of running beneath the surface of the water. The problem was a terribly difficult one to solve, but after two years of hard work and anxious consideration he managed to construct his first torpedo of the type which was for ever afterwards to be associated with his name. His only assistants in this work were his son, a mere boy, and a skilful and trusty workman. The first White-

1 In my description of the Whitehead Torpedo I have pillaged without stint the wonderful little volume by Lieut. Armstrong, in which is a complete and perfect history of the modern torpedoes and torpedo craft.

head torpedo was very different from the weapon we know to-day by that name.

The First 'Whitehead'

Material of hull.....	Steel.
Diameter.....	14 inches.
Diameter over fins.....	16 inches.
Weight.....	300-lbs.
Explosive charge.....	18-lbs. dynamite.
Air pressure.....	700-lbs. to the square inch.
Speed.....	6 knots.

This torpedo proved exceedingly erratic, and could not be made to keep its depth. At times it would run skimmingly along the surface, whilst at others it dived down to the depths and explored the bottom. Such marvellous promise did this initial torpedo show, and so vastly superior did it prove itself to any torpedo as yet devised, that the Austrian Government commenced a series of experiments with a view to discovering its true value. In 1868 Mr. Whitehead discovered the 'balance chamber,' which portion of the torpedo's anatomy was kept a profound secret until 1894.

Discovery of Balance Chamber

As the Austrian Government, for financial reasons, was precluded from securing the exclusive purchase of Mr. Whitehead's invention, the inventor entered into negotiations with other Powers, and offered an improved type of torpedo for trial and purchase. On the advice of a committee of the officers of the Mediterranean Fleet, the British Government requested the talented engineer to bring two torpedoes to England, with a submerged tube, for the purpose of carrying out exhaustive trials and experiments. Acting on these instructions Mr. Whitehead brought over the first two English torpedoes. They were of two sizes, and had the following dimensions.

Torpedoes brought to England

	Length.	Max Diameter.	Charge.
Large Torpedo	14-ft.	16-in.	67-lbs. Guncotton.
Small Torpedo	13-ft. 10½-in.	14-in.	18-lbs. Dynamite.

These torpedoes were identical except in dimensions. They had one propeller instead of two of the present day, and a projecting vertical fin both above and below running the whole length of the torpedo.

The 'Oberon' Trials

'The trials[1] were carried out on board the 'Oberon,' an old paddle-wheel sloop, and the torpedoes were fired from a submerged tube fixed in her bows, and ejected by an impulse rod driven forward by compressed air. In order that the capabilities of the torpedo should be tested in every direction, an apparatus was devised for discharging it from a boat or launch, and as many runs were made by this means as with the submerged tube. It is curious that the mode of launching now in most common use, namely, from a tube above water, was not adopted or indeed even tried, until some years later;[2] still for all that, the trials with the submerged tube and boat apparatus on board the old 'Oberon' showed quite clearly enough the wonderful capabilities of the new weapon. Over one hundred runs were made during these trials, and the average speed obtained was from 8.5 knots for a distance of 200 yards, and 7.5 knots for a distance of 600 yards. The adoption of the balance chamber showed that the difficulty of keeping a regular depth during the run was almost overcome, although the torpedoes still continued to be rather erratic and uncertain in this respect. At the conclusion of these trials the Committee sent to the Admiralty a report of their results and deductions. They affirmed, in the first place that the vessel which was stationary might be fired at end on, with every probability of striking, at a distance of 200 yards; that a ship at anchor might be struck broadside on at any distance up to 400 yards, but that a ship under way and going at a moderate rate of speed, could be struck with a fair degree of certainty up to 200 yards. Judging by the capabilities of the present day type of Whitehead, such a verdict as that given by the Committee seems to afford scant praise. Nevertheless the performances of the torpedo at that time eclipsed anything which has ever been seen before in that direction, and the committee were naturally impressed with the wonderful ingenuity and delicate construction of the machine.

'After these trials had been completed, experiments were carried out for the purpose of learning the destructive pro-

1 Copied from Lieut. Armstrong's book, pp. 13-15.

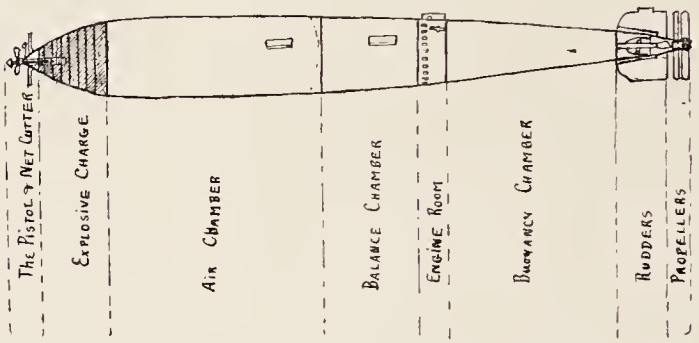
2 The above water tubes are being done away with as rapidly as possible in all British vessels (Author 1902)

perties of a torpedo if fired against a ship protected with a crinoline of nets. The old corvette 'Aigle' was selected for the ordeal. Anchored in the Medway, and surrounded with thick nets 80 feet long and 12 feet deep, suspended 15 feet from the ship's side, a large sized torpedo was then fired at her from the 'Oberon' at a distance of 136 yards from the net. This first shot, curiously enough, proved in a very forcible manner that the destructive powers of the torpedo were as great as its running was erratic. Although the target was perfectly stationary, the torpedo managed to pass just outside the edge of the net, and strike the ship under the quarter, with the result that the explosion tore a hole in her bottom 20 feet long by 10 feet, the centre of the hole being about 10 feet from the surface of the water. As might be expected, the ship sank down on to the mud immediately. Another torpedo was then fired, and this time with more desired results, the explosion taking place on the nose of the torpedo striking the net, the ship not being hurt in any way whatever. As a result of all these trials and experiments, the committee of investigation finally reported that in their opinion 'any maritime nation failing to provide itself with submarine locomotive torpedoes would be neglecting a great source of power both for offence and defence.' This decisive verdict was followed by equally decisive action on the part of the Admiralty. In spite of the protests and sneers of the old gunnery school of officers, the English Government showed their thorough agreement with the recommendations of the Committee by purchasing the secret and rights of manufacture of the Whitehead torpedo for £15,000. This recognition on the part of the first maritime Power in the world of the merit of the locomotive torpedo had the inevitable result. France, Italy, and Germany quickly followed our example, and at the present day every navy of importance, is using the Whitehead torpedo. No sooner had our Government completed the purchase than arrangements were at once made for torpedo construction in England on a large scale.' Torpedoes for the British Navy are manufactured by the Royal Gun Factory, Woolwich; Messrs. Whitehead and Co., Fiume, Austria; Harbour Torpedo Works, Portland; and Messrs. Greenwood and Batley,

Leeds. These torpedoes can be distinguished one from the other by the signs 'R.G.F.,' 'Fiume,' 'Leeds.'

Characteristics of the 'Whitehead'

The Whitehead torpedo, no matter of what type, has the following characteristics, commencing at the forward end, or nose of the torpedo.[1]



CCLIII. MARK IX. R.G.F. 14-IN. TORPEDO

The Explosive Chamber

1st. The Explosive Chamber.—This is in the head of the torpedo, and is exploded by means of a pistol, which consists of a striker with a needle point at the rear end. Behind it is situated a small case of fulminate of mercury[2] (the 'detonator') placed in the centre of a case of dry guncotton (the 'primer'), the latter being placed in the centre of a wet guncotton charge placed in the head. Wet guncotton is used because it possesses the property of not firing by ignition; the particles are only separated by the action of the striker impinging on the fulminate of mercury igniting the former and in its turn the explosive. This primer is inserted with the pistol at the last moment before firing the torpedo. A safety arrangement is fitted to all pistols to prevent the charge from being exploded until the torpedo has run the first 14 yards.

The Air Chamber

2nd. The Air Chamber.—This contains compressed air which supplies the motive power to the engines. This chamber is a cast-steel cylindrical shell, varying from .275 to .365-in. thick. The air pressure in the chamber of a Mark VIII., R.G.F. torpedo, which may be taken as a representative modern type, is 1,100 lbs. to the square inch for purposes of exercise, and 1,350 lbs. for action. In the older patterns

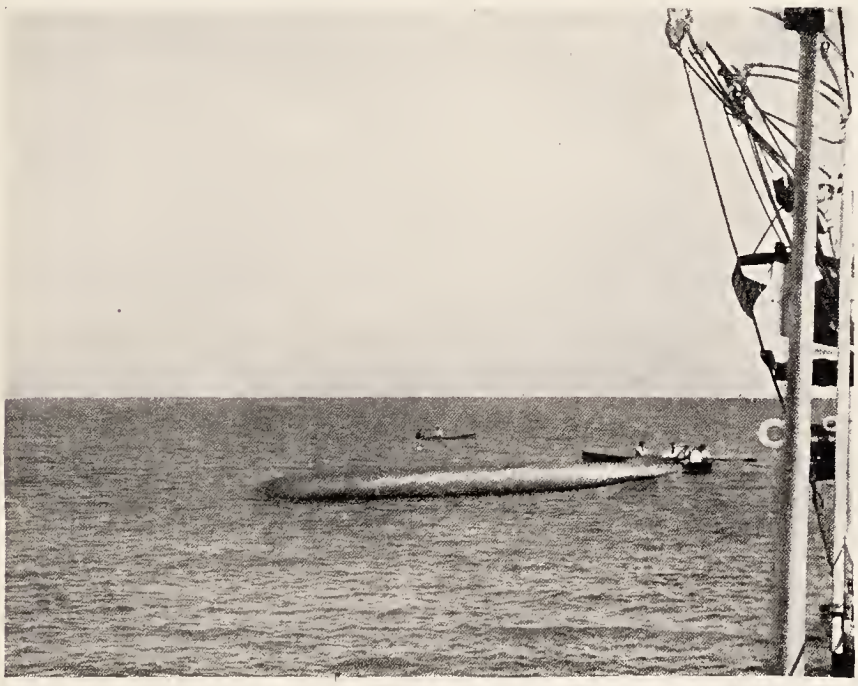
1 Laird Clowes' 'Naval Pocket Book,' 1901, pp. 660-667.

2 See 'Explosives.'

(Marks I—VI. 14-in. and Marks I—II. 18-in. short and long) the maximum pressure is only about 1,000 lbs. In the Mark VIII. torpedo the chamber is actually tested to a pressure of 1,700 lbs. to the square inch, a wonderful proof of the strength of the steel of which the chamber is made.

The Balance Chamber

3rd. The Balance Chamber.—This section contains the mechanism for regulating the depth below the water at which the torpedo is adjusted to run. The mechanism consists of a disc made water-tight to the shell of the torpedo by an



By favour of the 'Navy and Army Illustrated.'

CCLIV. A TORPEDO IN MID-AIR

indiarubber ring. This disc externally has the pressure of water acting on it; internally it is acted on by a strong spiral spring, capable of being adjusted to resist pressure of water at the depth at which the torpedo is required to run. In conjunction with this hydrostatic valve or disc, a pendulum weight works swinging fore and aft, due to the inclination of the torpedo. A series of levers and connections carry any motion of valve and weight to horizontal rudders situated in the tail. The mechanism is arranged so that when the tor-

pedo is above its depth the rudders are 'down,' and when below its depth 'up.' When above its depth the pressure of the spring is greater than the water, and the valve is forced out and the rudders down. The torpedo will then descend until the pressure of the water on the valve is greater than that due to the spring, when the valve will be moved in and the rudders consequently up, and the torpedo will ascend. The pendulum weight is necessary to modify the depth line of the torpedo, so that if it is inclined downwards and above its depth, or upwards and below its depth, the movement of the rudders shall decrease as the torpedo's inclination increases. The swinging of the weight can act with or against any movement of the valve. It will act with the valve if the torpedo ascends above or descends below its depth at too great an angle, and will give a large angle of rudder to balance this. It will act against the valve if the torpedo ascends or descends to its depth above a certain fixed angle of inclination, and will only then give a small angle of rudder in the direction of the inclination.

The Engine Room

4th. The Engine Room.—This contains the propelling and other mechanism. The propelling machinery or engines are all of the three-cylinder single-acting type, with the pistons connected to the crank. The crank-chamber and castings for the slide-valve form one casting, the valves themselves being of a cylindrical form. Unlike the ordinary slide-valve of a steam-engine, they perform only the operations of admission and cut off, the exhaust taking place through the ports in the end of the cylinder. To guard against the engines being on a dead point at starting, the propeller blades are placed beforehand in a certain position, which is indicated by arrow-heads. The I.H.P. of the latest pattern of 18-inch torpedo is no less than 56. Messrs. Brotherhood have the monopoly of the manufacture of all these engines for the British Government.

The Buoyancy Chamber

5th. The Buoyancy Chamber.—A thin steel chamber to give the necessary buoyancy to the torpedo. Through this chamber the shafting of the engines traverses by means of a special shaft-tube.

The Tail Section

6th. The Tail Section.—This contains the wheel gearing for conveying the motion of the engine shafting to the pro-

pellers. By means of this wheel gearing the two propellers, which are fitted, can turn in opposite directions, and thus keep the torpedo upright. The fore-propeller is right handed, the after one left handed, the pitch of both being the same. The horizontal rudders work on this tail frame, as also do the vertical rudders; these latter do not move. The torpedoes having once been adjusted to run in a straight line they are fixed to the tail fins.

The following particulars of the different types of torpedoes in the naval service, have been extracted from the Naval Pocket Book.

	Type	[1] Date	Length		Weight	[2] Speed	[3] Range	[4] Charge	[5] No. in Service.
			14-in.						
			ft.	in.	lbs.	knots.			
R.L. [6]	Mk. I.	1876	14	6	525	19·20	600	32	Obsolete.
,,	I.″	1880							
,,	II., II.″	1882	14	7	575	20·21	600	34	
,,	III.	1883	14	11¾	575	21·22	600	34	
R.L. & Leeds	IV.	1885	14	11¾	670	23-24	600	60	160
R.L.	V.	1886	14	11¾	680	23-25	600	60	175
,,	VI.	1887	14	11¾	685	25-26	600	60	200
R.L. & Leeds	VII., VII.″	1888	14	11¾	710	27	600	70	290
,,	VIII.	1893	14	11¾	705	26	600	65	930
R.G.F.	VIII.	1894	14	11¾	705	26	600	65	100
	IX.	1897	14	11¾	725	27	600	79	450
Fiume	IV.	1886	14	9	660	23-24	600	60	170
			18-in.						
Fiume	I.	1891	16	7½	1140	29	800	199	140
	II.	1895	16	7½	1140	29	800	185	280
R.G.F.	I.	1890	16	7½	1216	31	800	188	175
R.G.F.	II.	1894	16	7½	1216	31	800	188	120
	III.	1895	16	7½	1213	30	800	171	55
	IV.	1897	16	7½	1217	30	800	171	790
			Short 18-in.						
		1894	11	11¾	846	26	600	94	35
		1895	12	4	75	28	600	85½	65

1 Date of manufacture. 2 For 600 yards. 3 In yards.
4 Lbs. of dry explosive carried in head.
5 Approximate number only; continually changing.
6 R.L. = Royal Laboratory; same as R.G.F.

It will thus be seen that we have in the service something between 4,100 and 4,500 torpedoes, each capable of sinking the most powerful vessel afloat if hit in a vulnerable place.

Even if half of these were to take effect on the combined war-squadrons of the world (excluding obsolete gun-boats and torpedo craft) the fleets of the universe would be sunk more than twice over.

Of the types of 14-in. torpedoes mentioned above the Marks I, II, II', and III torpedoes of which but a few remain in the service, are considered obsolete. Marks IV, V, VI, have most of their fittings made of steel, whilst Marks VII, and VII' are made entirely of bronze, a metal not subject to the corrosive action of sea-water. Mark VIII R.G.F. is fitted with three-bladed propellers and is meant for use with torpedo-boats. The manufacture of these has been stopped as has that of the Fiume 18-in. Marks I, and II, owing to the complicated mechanism. Mark IX is the latest and best 14-in. torpedo, and is one very adaptable to submarine boats; its internal mechanism is strong, being copied from the latest types of 18-in. R.G.F. torpedoes. Of the 18-in. Marks I, II, R.G.F. are not satisfactory; Mark III is an improvement on them, but owing to the superiority of Mark IV the manufacture of these has been stopped. The short torpedoes were designed for boats dropping gear as long torpedoes are too weighty. They are bad depth keepers however, and no more will be made.

Obry's Gyroscope

The efficacy of the torpedo has been greatly augmented by the invention of an efficient gyroscope. This wonderful machine was devised by L. Obry, of Trieste, a retired engineer of the Austrian Navy. By the use of this apparatus any deflection of the torpedo out of its original line of fire is prevented, such deflection being produced either by the method of discharge or by some fault appertaining to the torpedo itself. It may be briefly described as follows.[1] 'In the buoyancy chamber is placed a small weighted wheel or gyroscope about 1¾ lbs. in weight, the weight of the whole apparatus being 15-lbs. This gyroscope is carefully suspended on gymbals in the centre lower part of the chamber in a vertical position and transverse to the axis of the torpedo. Attached to its

1 Lieut. Armstrong, p. 45.

own axis is a powerful steel spring connected with a toothed gearing, actuated by a rod attached to the air lever. The effect of the air lever being thrown back is to suddenly release the spring, which had previously been compressed by hand, with the result that the gyroscope is spun round at an enormous velocity—about 2,200 revolutions per minute. The gyroscope works a servo-motor actuating a pair of moveable vertical rudders ordinarily fitted, but which may be discarded if a gyroscope is being used. If now, the torpedo from any cause, external or internal, be deflected out of the line of fire, the gyroscope by maintaining its axial position in the line of fire, acts on the servo-motor, and by means of the vertical rudders steers the torpedo back again to its original direction. This apparatus is being supplied to every efficient torpedo in the service, since with it, torpedoes have run accurately a distance of 2,000 yards.' The cost of the gyroscope, with royalties, is £50.

Germany The Schwartzkopf

Most countries have adopted the Whitehead, although some preference has been shown for the Schwartzkopf [1] by the Triple Alliance, whilst America favours the Howell. The following notes may be of interest.[2]

France

All the French Torpedoes are of the Whitehead type, either manufactured at Fiume or the Government Factory at Toulon. The most modern has the following dimensions:—

Length.	Diameter.	Charge.	Speed
16.40-ft.	17.72-in.	198	29.5 knots.

About 100 torpedoes a year can be manufactured at Toulon; besides the type mentioned above there are five others, two long and three short.

Russia

Russia's Whitehead torpedoes are made either at the Oboukkov Works or the Löesner Factory, Petersbourg.[3] About 50 a year are turned out, but a new factory is shortly

1 The Schwartzkopf are manufactured at Berlin, and in October, 1888, the manufacture of the 2,000th torpedo of this type was celebrated. Italy has 700 in service, and Japan in 1887 ordered 150 which orders have only recently been completed.

2 Chiefly from the 'Naval Pocket Book.'

3 A torpedo depot was formed recently at Sebastopol.

to be opened, and the capacity is expected to be doubled. The type in favour at present is:—

Length.	Diameter.	Charge.	Speed.
19.68-ft.	17.72-in.	300	30 knots.

The Schwartzkopf is as much in use as the Whitehead, but its manufacture has been given up in favour of the latter weapon.

Italy

Italy uses both Whitehead and Schwartzkopf torpedoes, the latter being of phosphor-bronze; the sizes employed are 17.72-in. and 14-in.

Austria

For the defence of Bukar Bay, the Austrian Government has had made by Messrs. Whitehead, fifteen torpedoes of the following dimensions:—

Length.	Diameter.	Speed.
19-ft. 8-in.	18-in.	22 knots for 2000 yards with gyroscope.

Spain

Spain uses the Schwartzkopf type of torpedo almost exclusively, and has just recently commenced their manufacture at Carthagena.

U.S.A. The 'Howell' Torpedo

The United States uses both the Whitehead 18-in., manufactured by Messrs. E. W. Bliss and Co., at Brooklyn, and the Howell, which last has as its motive power not compressed air, but a fly-wheel to which rapid motion, previous to the instant of discharge, is imparted by mechanical means. This is an American invention, produced by Rear-Admiral Howell, in 1871. The high velocity of 10,000 revolutions per minute is obtained for this fly-wheel, and the stored up energy of the wheel is sufficient to turn the propeller screws and drive the torpedo at a high rate of speed. The revolving wheel also serves to keep the motion uniform in direction, it acting on the principle of the gyroscope.[1] The range exceeds 800 yards, the speed up to 400 yards being 26 knots. The newest has the following dimensions:—

Length.	Diameter.	Weight.	Charge.	Speed.	Extreme. Range.
14-ft. 6-in.	17-in.	1,130-lbs.	174	33	1000

1 'The American Navy,' Charles Morris.

By favour of the 'Navy and Army Illustrated.'

CCLV. A WHITEHEAD LEAVING THE TUBE

For 400 yards the speed is 33 knots; 30 knots for 600 yards, and 28.5 knots for 800 yards. Out of 346 shots with the tube 2½ feet above the water, there were 332 hits, 10 misses, and 4 accidents; with the tube 9½ feet above the water 63 hits out of 69 were scored. The target was 21 yards long, and one yard wide, 8 feet below the surface. In 1894 out of 428 shots 403 hit the target, 11 missed, and 14 were accidents.[1]

Japan

This rising Power favours the Schwartzkopf, but has also Whiteheads in the Service. Messrs. Whitehead are at present manufacturing for Japan a torpedo of the following dimensions:—

Length.	Diameter.	Charge.	Air Pressure.	Speed for 3,000 yards.
16-ft.	24-in.	200-lbs.	4,500-lbs.	25 knots.

This torpedo would, on account of its weight, be out of the question for submarine boats.

The 'Peck' Torpedo

Amongst other torpedoes I may mention one by a Mr. Peck,[2] who proposed to propel his invention by steam, and another type, the inventor of which is unknown, driven by compressed liquid carbonic acid with a steering apparatus actuated by a magnetic needle. The idea, if impracticable, is certainly ingenious, but neither of the two mentioned above seem to have much chance against the Whitehead, 'the only invention that was perfect when devised.'

General Berdan's 'Net Cheater'

Perhaps the most ingenious torpedo ever proposed is the 'net cheater' of General Berdan. This consists of two torpedoes joined one behind the other by a short cord of say 10 or 12 yards in length. There were two methods of operation for the apparatus.

Method of Employment

1st. In the case in which the first torpedo was loaded.—In this event, the net or other obstruction would be destroyed by the explosion of the first torpedo, and the second could then follow on through the aperture so caused. The explosive matter in the front projectile would be just sufficient

1 'Les Torpilles Automobiles.' Ed. Bara et H. Noalhat, p. 112.

2 This torpedo, offered to the Government in 1887, was 14 feet long and 14 inches in diameter; it carried a charge of 100-lbs., and had a speed of 30 knots for 600 yards (?), and an extreme range of 2,250 yards.

to tear the net and not enough to explode the second torpedo

2nd. In the case in which the first torpedo is not loaded. —On striking the net, the trigger of the first torpedo will jerk the cord attached to the second torpedo, this movement inclining a pair of rudders in such a manner that the torpedo will dive under the net until the cord (after 10 or 12 yards has been run) again becomes taut, reversing the rudders. The torpedo then rises again, and striking the bottom of the ship destroys it in the most approved fashion. Another automobile torpedo was the invention of Lieutenant M. E. Hall, of the United States Navy.

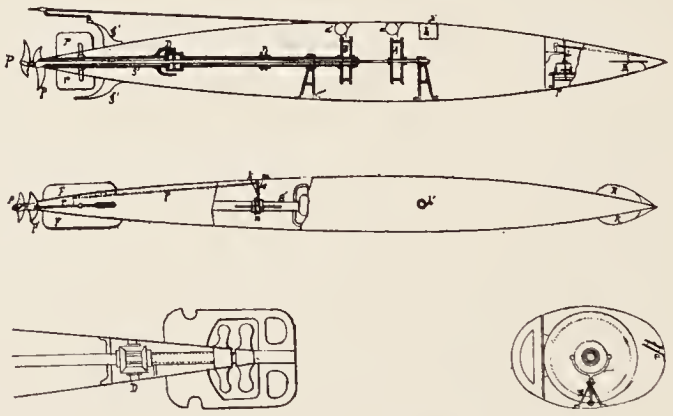
The 'Hall' Torpedo

Controllable Torpedoes.

As these are not likely to be of much use for service with submarine boats, I will dismiss them with a short summary of the various types.

Mr. Brennan was a poor watchmaker, of Melbourne, when the idea of this torpedo occurred to him. In 1880 a committee appointed by Ad. Wilson having reported favourably

The Brennan



CCLVI.-CCLIX. THE BRENNAN TORPEDO

on it, Brennan was ordered to England, and in 1882 was paid a retaining fee of £5,000, and engaged for three years at a salary of £2,000 a year and all expenses paid on condition that he devoted all his energies to the improvement and development of his invention, of which an illustration appears above. He afterwards received a reward of £110,000 and a

salary of £1,500 for five years. The great fault of the Brennan is that it cannot return to the starting point, though it can twist and turn about in any direction within an arc of 40 degrees each side of right-ahead.

The course of the torpedo is marked by a cloud of smoke emitted from the Holmes light fixed on its nose, and at night by the flames from the same rising to the surface of the water. On October 26th, 1886, torpedo boat No. 69 left Sheerness Harbour at a speed of 16 knots, towing a small target. A Brennan torpedo was launched from Garrison Fort, and, directed by Mr. Brennan himself, it caught up the target and pierced it in the centre. This is the Brennan, at its best. About fifteen months ago (September, 1901), fifteen years after the trial mentioned above, the same torpedo was tested, and successfully sunk a deeply laden barge, to the great annoyance of the officers of the Garrison Fort and the crew of the sunken vessel, but to the huge delight of newspaper reporters. Whether the Brennan is worth the £150,000 odd that has been spent on it, is a subject of some discussion. My own opinion I will reserve.

Ericsson

This well-known inventor, who it may not be generally known, was an Artillery Captain, constructed a steerable torpedo, having the following dimensions:—

Length.	Diameter.	Weight.	Charge.
19-ft.	15-in.	1,322-lbs.	220-lbs. of dynamite.

J. Lay

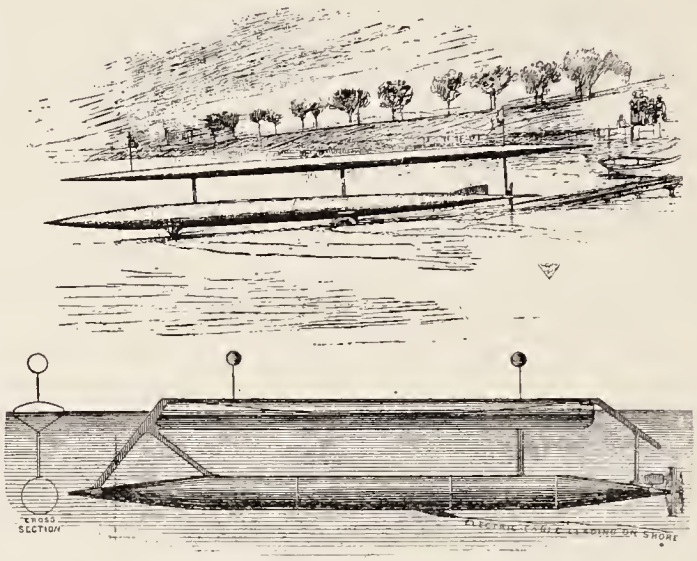
A truly formidable thing to run against. The next torpedo is that of John Louis Lay,[1] who patented his invention on June 13th, 1873. It was cigar shaped, and supported by a float. The dimensions are as follows:—

Length.	Diameter.	Weight.	Charge.
26-ft. 3-in.	24-in.	1½ tons.	88-lbs. of dynamite.

The appended sketch is from an article on torpedoes by

1 Tried in the Bosphorus on November 9th, 1882, before Hassan and Hobart Pachas. The speed obtained was only 8 knots instead of 15 promised by the inventor.

Lieutenant Hughes, which appeared in Scribners some time ago.[1]



The Sims-Edison Torpedo.

CCLX.-CCLXI.

Sims-Edison

This torpedo, illustrated above, has the following dimensions: —

Length.....	28 feet.
Diameter.....	21 inches.
Weight.....	4004-lbs.
Speed.....	11 knots.
Charge.....	396-lbs. of dynamite.

The Sims-Edison torpedo was purchased by the U.S. Government in January, 1886. Steering is done by means of electric magnets, and propulsion is obtained through electric power conveyed by means of 3,500 yards of cable stored in the torpedo.

'Lay-Haight'

Other controllable torpedoes are the 'Lay-Haight,' a modification, capable of making 16 knots, of that invented by John Lay; the 'Patrick,' a cross between the Sims-Edison and the Lay, driven by carbonic acid gas, and having a speed of 12.67 knots on trial; the 'Nordenfelt,' an electric

Patrick

Nordenfelt

1 'Scribner's Magazine,' April, 1887, 'Modern Aggressive Torpedoes,' Lieut. W. S. Hughes, U.S.N.

torpedo, patented by Mr. Nordenfelt in 1883, and of which the following are a few particulars :—

Length.....	35 feet.
Diameter.....	29 inches.
Weight.....	6295-lbs.
Charge.....	330-lbs. of guncotton.
I.H.P.....	18.
Speed.....	14 knots.

The 'Nordenfelt' was tried before the Admiralty on June 28th, 1888, in the Thames at Erith. Some years after a more powerful engine (34, I.H.P.) was fitted and a speed of 16 knots obtained. Unfortunately this would be useless for war purposes, all vessels having speeds of only 16 knots being now almost out of date.

M. Paulson

Mr. M. Paulson's torpedo, tested in 1886, off the coast of Norfolk, was driven by carbonic acid gas. It presented several novel features, and amongst them was the power to turn corners automatically. By this I mean, the torpedo could be fired from behind a projecting cliff and be made, by setting the interior mechanism before releasing the projectile, to turn at right angles, round the cliff and hit a vessel out of sight of the operator. It carried, besides, a small charge (10-lbs. of guncotton) to blow a hole in the Bullivant net and allow the main torpedo with a heavy charge to pass through and destroy the vessel attacked. The extreme range of this weapon was 2,000 yards.

J. Smith

M. Julius Smith, a mechanician of Boston, exhibited a torpedo at the 1872 Washington Exhibition. It was, as is the case with most automobile torpedoes, suspended from the surface by a float, and was driven by electricity, the current being stored in accumulators in the torpedo. The steering alone was effected from the shore, by means of an insulated wire.

The Actinaut.

The invention of Messrs. Orling and Armstrong is better described in the words of their pamphlet, 'The application

of the Orling-Armstrong Actinaut to Naval Warfare, Coast and Harbour Defence' by J. Tarbotton Armstrong.[1]

'To describe the 'Actinaut' as a torpedo would be misleading, for a torpedo is simply and solely a projectile, while the 'Actinaut' comes under the category of a Submarine Boat, without any hands on board. It can be anchored near to or miles from the shore, and can be thrown over-board from a man-of-war or any other craft, and it renders submarine mines unnecessary, and to a considerable extent fortifications and heavy batteries.

'It is now felt by all authorities who have any knowledge of the subject that the question of our Coast Defence has to be seriously considered. The Century which has just closed has practically revolutionised the Navy, and Submarine Boats have proved to be the new feature that may operate very materially with reference to the Coast Defence of this as well as any other Nation, but it is doubtful if the best yet equipped can hold their own when attacked.

'The French Government, who have well studied this question, have decided that an additional credit of 50 million francs shall be devoted to the construction of torpedo boats and submarines, and everything points to the submarine boat or something of a similar nature as being what is required in the future for Naval and Coast Defence purposes.

'It is now being strongly urged in this country that a Special Commander-in-Chief shall be appointed to command the whole of the Defences of the Ports, and a very high authority, writing some time since, said that one of the many improvements we should like to see effected was the inauguration of a Fleet of Submarine Boats, and he expressed the hope that the Nation would see early in the new century the possession of 60 such boats.

'By the system known as the Orling-Armstrong Submarine Boat or 'Actinaut,' it is thought that the question of our Coast Defence is once and for all settled. These Boats cannot be compared with the ordinary Submarine Boat which has to be of a very large size and to have a considerable

1 It must be remembered that this pamphlet is by way of being an advertisement and a prospectus for possible investors. As a prospectus it would be useless without the rosy future prophesied for it in these few paragraphs.

crew on board, besides being very expensive in its construction.

'In the present imperfect state of development, the Submarine or submergible boat seems likely to do more damage by accidental collision than by proposed torpedo firing. In either case the position of the crew of the attacker would be more precarious than that of the attacked, but the story of the Submarine 'David' having drowned three crews before she blew up the 'Housatonic' and drowning a fourth, indicates that these vessels will not be laid up in war time for the want of men daring enough to work them. With the Orling-Armstrong Submarine Boat, all this is obviated, there being no crew, and there is no doubt that the moral effect of the knowledge that the 'Actinauts' are about, is bound to be considerable and to lead to demoralisation in an enemy's fleet.

'The Submarine Vessels in existence up to the present time require a crew of twelve hands for each boat, and to even save this number of hands is a consideration, without taking into account the first cost of the boats or their maintenance.

'Thirty-eight Submarine Boats are provided for in the present Naval programme in France. The money 'ear-marked' by this decision indicates that the French people are backing up the opinion of their Naval advisers in favour of this new class of warship to the extent of over a million pounds. For the same sum of money over 1,500 'Actinauts' can be built.

'The Submarines of the Orling-Armstrong system are cheaper than even Torpedoes, not to mention Submarine Boats, they can be operated with certainty from almost any distance, and are so simple in their construction that our Coast Guardsmen can manipulate them after a very little experience.

'Another great feature in connection with these 'Actinauts' is that they are always operative at a moment's notice.

'They can be moored out in the open sea or on the sea shore, or can be thrown over-board from any vessel and manipulated by invisible radiation.

'Whilst it would take many years to equip our coast with the ordinary Submarine Boat, the Orling-Armstrong could

be supplied in almost so many months, so cheap are they and so easily and quickly made.

'It has taken close upon five years in experimenting to make this system effective, but the Inventors are now well repaid for their trouble and expense in being able to put upon the market a system, which if adopted by the British Government, will practically and effectively settle the question of our Coast Defences, releasing the Guard Ships for service with the squadrons.

'With this new submarine is it not obvious that a new feature is introduced for modern naval warfare, that is destined to revolutionise all present accepted ideas?

'The Government must see that the system that is adopted is the most perfect for the object to be attained, and it is felt that no more effective or cheaper plan can be adopted than the 'Actinaut.'

'Granted that a submarine can be so worked that the range of clear vision is not obscured (which is very doubtful), and that the projectile reached its mark and blew up the warship, it would also blow up the submarine, because none of the craft so far invented possesses speed enough to get out of the danger zone in time. This does not matter with the Orling-Armstrong submarine.

'It is supposed that everyone knows that at the explosion of a torpedo under water, sufficiently powerful to sink an ordinary battleship, the said explosion would produce a shock that would damage in the same way as it does a battleship, anything else of an explosive nature within the radius of at least a couple of hundred feet. It is well known that this is the principle on which submarine mines defending a harbour are exploded by an enemy, but this is done by means of a torpedo, travelling a mile or so before it strikes its objective and at that distance the attackers are perfectly safe, but in the case of a submarine, it is necessary to take account of the very probable dislocation of essential machinery inside the same, which would mean either suffocation of the crew under the water or the blowing of the submarine into scrap iron the moment its hull on rising to the surface should appear within range of the quick firing guns. This is all obviated in the Orling-Armstrong Submarine.

'Again the submarine could only attack effectively in quite calm water. She must rise to the surface to mark down her prey. In heavy weather this would be impossible. It is obvious that this does not effect the Orling-Armstrong, because she is guided whilst below the surface from a distance, say, the shore or a ship or boat, by invisible radiations by the spectators from the shore or on board ship or boats.

'It is admitted that if an ordinary torpedo boat can steer straight towards an opponent, her power for mischief is heavily discounted as long as an enemy is in motion, but with the 'Actinaut' she is made to follow the vessel till she strikes her prey.

'It is certain that the ordinary submarines cannot venture on the surface any nearer than, say, a mile of her objective. If then undiscovered she has to sink and to make her way towards her antagonist at a maximum speed of but a few knots per hour. But if her object is moving, she will never reach it at her present speed, even if she can see it. Nothing of this sort will happen with reference to the Orling-Armstrong Submarine.

'The bulk of a submarine boat is necessarily great, and the maximum weight of her engines is soon reached while their power is much too small to give her any useful speed at the depth she has to travel, and for her own safety she must go deep enough to clear the keel of any deep-going vessel. Thus it must seem clear to every sober mind that a submarine boat will have no effect in following a vessel that is going at a moderate speed.

'The 'Actinaut,' containing nothing but her engine, power chamber, steering mechanism and explosive head, is very small, and for great speed most suitably shaped, and the depth at which she is to strike a doomed vessel is about ten feet, and that is her constant depth when running.

'Nor does the 'Periscope' seem to us to justify the expectations of its Inventor. From the descriptions that have been seen of it, it is simply an eye-piece attached to the top of a rigid or hinged mast. The ultimate result is that the officer below, has before him, as in the Camera Obscura, the picture of what is seen by the eye some 20 or 30 feet above. But in the first place that eye can only see from the surface,

as a man could see if he were swimming. The 'Periscope' will rapidly be obscured by spray and encrusted with salt, and in the second place, the speed of the Craft, already insignificant, compared with that of a moving opponent is yet further diminished by the drag of a mast some twenty or thirty feet long beneath the water. Seeing that the Orling-Armstrong Submarine is manipulated at a distance miles away, all these difficulties are obviated.

'One of the great difficulties with reference to the ordinary submarine, is, how is a distance to be measured when a craft is submerged, or how is the submarine to know when she is within striking distance. These are difficulties that are entirely obviated by the Orling-Armstrong system.

'Many authorities have again and again pointed out that the Orling-Armstrong Submarine is a real menace in the narrow waters of the Channel, and that if this system be entirely adopted by the British Government, the Country will be perfectly safe from invasion. We need scarcely say that the Country has the greatest ground for disquietude, taking into consideration what other Nations are doing with reference to the submarines, unless some better system is adopted. It is here, as it has been with combustible fittings, ammunition hoists, and end to end armour belt, that the Admiralty are behind their rivals.

'There is no excuse for the Government not fully testing the Orling-Armstrong system, because everything in connection with the same is so very cheap and the good qualities can be so easily proved at small cost.

'We will now illustrate in a typical manner the best means of installing a system of Coast defence, and the same will apply with very small modifications if worked from a ship. Supposing at the Coast Guards Station, say, for instance, on the top of the cliffs at Dover, there is placed the apparatus necessary to guide the 'Actinaut.' Out at sea or in the harbour are anchored several 'Actinauts.' An enemy's ship is seen advancing, say, from the French Coast, and as soon as the operator (who is well trained) thinks fit, a button is touched and this immediately releases an 'Actinaut' (and at the same time starts her machinery). The operator simply guides her as already stated by means of invisible radiation,

entirely under his control till she strikes the vessel, but another operator can at the same time be working another 'Actinaut' having the same object in view without in anyway interfering with each other, or a third operator can be working another 'Actinaut' to another vessel if one is seen approaching. Supposing now it is thought best not to allow the 'Actinaut' to follow the ship she can be brought back to any station or ship.

'With the use of the 'Actinaut' there is no need for submarine mines; the difficulty with these is that they become dangerous to the ships of the attacking Power, and then a ship must be seen on the mine from two angles by two lookouts before it can be blown up or the ship passes to the left or right of the mines, but let the 'Actinaut' be anchored where the mines are; she can be released and made to follow the ship until blown up. The advantages of this will be obvious to anyone; nothing is so effective or so simply worked as the 'Actinaut' for harbour or coast defence.

'The cruisers that are in connection with our fleet all over the world could be rendered far more effective in fighting efficiency by being equipped with the 'Actinaut,' and if this were done with them as well as with destroyers few larger vessels would be required.'

With the description of the 'Actinaut' the history of torpedoes comes to an end. Whatever the future of the 'Actinaut' it can never take the place of the submarine. The Brennan Torpedo, it will be remembered, was to have driven battleships off the sea, and yet England builds her 'King Edward VII.'s,' France her 'Republiques,' America her 'Virginias,' Germany her 'Barbarossas,' Russia her 'Borodinos,' and Italy her 'Regina Elenas,'——the battleship does not seem to have *quite* disappeared after all is said and done. Neither the submarine boat or any type of torpedo will for many years to come drive the battleship from the sea. The 'Actinaut' is part of the natural sequence of events resultant on the discovery,[1] or rather, practical application of wireless telegraphy, and we can only consider therefore this latest 'revolution of Naval Warfare' to be the ordinary evolution of the modern torpedo—the progress of time—an inevitable

1 The possibility of wireless telegraphy was known in 1854.

step in the advancement of modern science. After all, it is only a torpedo and nothing absolutely new. The torpedo itself when it appeared in the early sixties, was a revelation—an unlooked for and entirely novel method of offence; its effect on warfare has been far greater than any effect the 'Actinaut' can possibly produce. Still it is not well to decry new inventions especially one so full of promise as this controllable torpedo. Its superiority over the 'Brennan' is evident, and for Coast Defence there is little doubt but that the 'Actinaut' will prove invaluable. Perfect as it appears to be from the experiments already carried out, there is probably still room for improvement, and we shall no doubt shortly hear more of this highly ingenious invention. The question is, will the Government obtain it?

X. Explosives.

The germ of all the knowledge of explosive reaction we possess undoubtedly lies in the probably accidental discovery, many ages ago of the deflagrating properties of the natural substance, nitre or saltpetre, when in contact with incandescent charcoal. Of the consequence of that discovery and the progress to the present knowledge of explosives, gradual as it has been, I have neither the space nor the knowledge to treat. All I wish is to give a short description of the constituents and properties of one or two of the best known explosives with which submarine navigation is intimately connected. Now the objects to be obtained in the production of an explosive agent are five.

(a) Maximum of propelling force.
(b) Minimum of initial pressure on the bore of gun.
(c) Uniformity of action.
(d) Freedom from fouling.
(e) Durability.

Gunpowder.

Of all explosive substances at present known, gunpowder alone can be said to fulfil the first three conditions. But where-

as these conditions are imperative in the use of an explosive as a propellant for missiles, they are by no means necessary in a high explosive for free bursting.

Composition

Hence for torpedoes guncotton, dynamite, or even more powerful explosives can be adapted with the greatest success. The earliest powders we hear of were composed of equal parts of saltpetre, charcoal, and sulphur, but gradually the quantity of saltpetre was increased until, after centuries of experiment, gunpowder—pure and simple—has reached a definite composition which cannot be altered without detracting from its value as an explosive. If other constituents be added then, naturally, a more potent force can easily be obtained, but the simple combination of the three substances mentioned above has reached a finality to change which would be a retrogression. The following are the compositions adopted by the five chief powers:—

	England.	France.	Russia.	Germany.	America.
Saltpetre	75	75	75	76	75
Charcoal	15	12.5	15	14	12.5
Sulphur	10	12.5	10	10	12.5

The similarity of the solutions arrived at clearly leads one to the conclusion that the right relative amounts of each substance are used to obtain the greatest efficiency.

Saltpetre

Charcoal

Saltpetre or nitrate of potash is a compound containing 54 parts of nitric acid and 46 of potash. Charcoal is the charred woody fibre or residue which remains after the liquid or more volatile parts have been driven off by destructive distillation. Charcoal is best fitted for the manufacture of gunpowder when prepared from light spongy wood, containing a very small proportion of mineral substances. The value of woods for charcoal are in the following order:—Dogwood, Willow, Alder, Filbert, Chestnut, Hazel. For the manufacture of powder only the crystalline variety of sulphur, soluble in bisulphide of carbon, is used. Sublimed sulphur, commonly called 'flowers of sulphur,' which consists of minute granules of insoluble sulphur enclosing the soluble variety, is considered unfit for gunpowder. It is surprising what care is required in the preparation of these three ingredients to ensure a good

Sulphur

result. Even after they have been purified and repurified the combination may be mediocre owing to an over-due amount of moisture in one constituent or an excess of heat in the preparation of another. But although all these matters are of the utmost importance and require the most careful study, no physical property affects the explosiveness of gunpowder as much as its density. Other things being equal, increasing the density decreases the initial velocity, and *vice versâ*, a less dense powder gives a higher velocity, but also where cannon are concerned a greater strain to the metal of the gun.

In torpedoes, however, where the maximum of force is the chief feature to aim at, most of these difficulties are removed, and the initial velocity may be of the greatest; for in any case on ignition the torpedo will be destroyed, and it makes very little difference whether the destruction takes the form of minute pulverisation or a mere splitting of the steel shell so long as the full destructive force of the charge takes effect on the hull of the vessel against which the explosion takes place. As intensity of explosive force is the main requirement, gunpowder was soon put on the shelf to give place to guncotton and dynamite, and I will now give a short description of each of these.

Guncotton.

Discovery by Pélouze

Guncotton (known in different countries as:—Pyroxilin, Coton poudre, Fulmi coton, Schiessbaumwolle) was discovered in 1838 by Pélouze, who observed that when cotton fabrics or paper were immersed in cold concentrated nitric acid for a short time, the free acid being subsequently removed by washing, these materials became, without important alteration of structure, converted into substances possessed of high explosive properties. Seven years later Schönbein announced the discovery, and at once proposed it as a substitute for gunpowder. Shortly afterwards, the value of the new explosive being readily perceived, a number of well-known scientists, Böttger, Béchamp, Crum, Gladstone, Hadow, Von Kirchhoff, Péligot, Pélouze, Porret, and Sobrero, made guncotton the subject of much earnest study, and various formulæ were proposed as representing its composition. Crum was the first to

Schönbein

Crum

entertain the view that guncotton might be regarded as cellulose, in which the two or three atoms of hydrogen are replaced by their equivalent of nitric-peroxide; this formula confirmed by Hadow, was afterwards supported by Schrötter, Redtenbacher, and Schneider, in their joint investigation of guncotton manufactured in Austria by the improved process of Von Lenk, and though again disputed by Pélouze and Maury, the correctness of the formula $C_6 H_7 N_3 O_{11}$[1] originally proposed by Crum was conclusively established in 1866 by the exhaustive analytical experiments of Abel.

Susceptibility to Detonation

The susceptibility of guncotton to detonation when wet gives this substance a great advantage over other explosive agents, as it may be stored in a perfectly harmless condition (wet guncotton being quite unalterable), and at once used in that state as a powerful destructive agent through the agency of a detonating charge. The explosive force of guncotton is to gunpowder as 3 to 1.[2] Another type of guncotton is that known as 'Tonite,' first manufactured by Abel. This explosive may be expressed as guncotton prepared with barium nitrate; the generated force being on explosion dispersed with greater rapidity, this type is especially useful for the blasting of ground mines.

Tonite

Dynamite.

Dynamite, a word derived from the Greek, meaning Strength, is a term used to express a variety of explosives containing nitro-glycerine. It first made its appearance in the form of gunpowder, soaked in nitro-glycerine, when Alfred Nobel in 1863 used this compound for blasting. In 1867 the Swedish Scientist conceived the idea of mixing it with earth, owing to its explosive properties in a free state, and to the mixture thus obtained he added a little alkaline material to neutralise any acid that might be set free by the nitro-glycerine; to this preparation he gave the name 'dynamite.' Ignited in the open air, dynamite burnt slowly and steadily,

A. Nobel

1 Expressed by Hadow as 'Trinitrocellulose,' this being the term for the explosive agent contained in the compound.

2 Sarrau gives it as 3.06 to 1; Berthelot as 3.42 to 1, but this is certain to change with the efficacy of the experimental charge.

but it may be readily exploded through the agency of a mercuric-fulminate detonator, and though not equal to nitro-glycerine (the substance sometimes employed by its detonation) in bursting or breaking power, it is vastly superior to gunpowder, and several degrees stronger than guncotton, to which it bears a relation of 4.5 to 3 and to 1 of gunpowder.[1]

Composition

Dynamite is now prepared from 20 to 25 parts of nitro-glycerine, with 75 to 80 parts of finely pulverised burnt clay from glass works.[2]

NITRO-GLYCERINE.[3]

Discovery by Sobrero

This high explosive was discovered by Sobrero in 1846, and is formed by the action of concentrated nitric-acid in the presence of strong sulphuric acid, upon glycerine at a low

Preparation

temperature. It may be readily prepared by dropping glycerine into a mixture of the acids,[4] the mixture being kept artificially cooled; and afterwards pouring the whole into cold water, when the nitro-glycerine separates as a heavy transparent, sweet smelling pale yellow liquid. I should not however advise amateurs to attempt its manufacture, for having obtained it to handle it without expert knowledge is to court death. The first attempts to utilize its explosive power were made by Nobel in 1863, but they were only partially successful.

Value

The value of nitro-glycerine in the form of 'blasting gelatine' (the only way in which this explosive can be safely transported) is very great, and in several cases it is rapidly taking the place of dynamite, to which it is of course

Ratio of Strength

analogous. Its power is to gunpowder as 4.8 to 1, though Berthelot puts it as high as 6.8 to 1, and he is probably more nearly correct;[5] this substance when not detonated is very uncertain in its action, but when so ignited is amongst the most reliable of all high explosives.

1 'On Recent Investigations and Applications of Explosive Agents,' Sir F. A. Abel, 1871.

2 M. P. Champion's formula.

3 Also known as Glonoin, Glonoin Oil, Blasting Gelatine.

4 Two of Nitric to one of Sulphuric Acid; and Glycerine an eighth of the combined weight of acid.

5 Sarrau only allows it 4.55 to 1.

Cordite.

Cordite is the result of experiments carried out under the supervision of Professor Dewar and Sir Frederick Abel. It consists of

Nitro-glycerine.	Guncotton.	Vaseline.[1]
58 per cent.	37 per cent.	5 per cent.

The vaseline is present solely as a lubricator to lessen the friction in the bore of the gun, it also gives a water-proof nature to cordite, and assists in producing a mixture that is easily squeezed into a cord. Cordite is manufactured in long sticks or cords, and has the appearance of solidified soft soap. It is quite odourless and harmless, being the safest of all explosives; it can be held in the hand and lighted without danger, and will burn without smoke or residue with a bright flame. The value of cordite as a propellant in comparison with gunpowder may be seen by the following table, which shows the power exerted by both explosives in a 4.7-in. Q.F.

	Projectile.	Charge.	Muzzle Velocity.	Pressure.
Cordite	45-lbs.	5-lbs. 7-oz.	2,180[2]	15 tons.
Powder	45-lbs.	12-lbs.	1,780	16 tons.

The full charge for the 12-in. B.L. was 295-lbs. with black powder, but with cordite it has been reduced to 167½-lbs. The French equivalent to cordite (or smokeless powder) is a preparation of nitro-cellulose and tannin, with certain quantities of nitrate of barium and potassium. Other high explosives at present used are, Mélinite (used by the French Government, and said to be superior to any other type); Lyddite,[3] now in common use in the British Navy, a particularly evil smelling compound, containing Picric Acid, manufactured primarily at Lydd; Maximite, the invention of

Mélinite

Lyddite

Maximite

1 'Naval Gunnery,' Capt. H. Garbett, R.N., 1897.

2 This has been exceeded since with a very slight augmentation of the charge.

3 Lyddite is made in sticks about the size of a candle; it has a brick red appearance, and resembles sand in form. It burns brightly if a match is applied, but does not explode.

Mr. Hudson Maxim.[1] Dualin, Nitro-Mannite, Lithofracteur, Potentite, Lignin-Dynamite,[2] Picrate of Potash, and many others of less importance.

Detonators.

Fulminate of Mercury Preparation

Fulminate of Mercury is produced by adding alcohol under careful precautions to a solution of mercury in nitric acid. A very heavy grey precipitate is obtained, and this has to be kept in the wet, for so sensitive is it to explosion that the vibration of an object in the vicinity has been known to ignite it. Of all substances at present known none is more sensitive than this fulminate, and it is for this reason much employed in torpedo work. The manufacture of detonators is perhaps the most dangerous employment a man could wish for. A particularly delicate business is the soldering up of the junctions. In doing this the operator holds the fuse and the soldering irons with his hands inside a metal case, so that in the event of an unexpected explosion the detonator will have to be satisfied with simply blowing off the operator's hands instead of expending its energy amongst surrounding objects.[3]

Fulminate of Silver

Fulminate of silver is prepared in a similar manner to the mercuric fulminate, but is even more sensitive, a note struck on a piano in a room in which is a small quantity of this preparation in the dry state being amply sufficient to cause its explosion. Owing to the difficulty of handling so sensitive a substance it is of little practical value.[4]

Xyloidine

Xyloidine is an explosive coming between Nitro-glycerine and Fulminate of Mercury, as regards force of ignition, being a compound of nitric peroxide and starch; it is a powerful explosive, but is too sensitive as a propellant and not sensitive enough for a detonator.

1 Often erroneously confounded with Sir Hiram Maxim.

2 Used by the Fenians in 1883.

3 'Torpedoes and Torpedo Vessels,' Lieut. Armstrong, p. 108.

4 Crackers are prepared from minute quantities of Fulminate of Silver.

PART VII

MILITARY VALUE OF THE SUBMARINE

IT is not without some qualms that I start on the final section of this work,—a discussion as to the probable uses to which the submarine may be put in future wars. Any such discussion is of necessity theoretical, since there is no date, no historical fact from which to draw conclusions, or on which to base opinions. Prophecy is untrustworthy, and indeed impossible in matters of this nature, the sole method by which a few conclusions may be arrived at being that of deduction,—deduction from the trials of the craft in time of peace. By this alone can we gauge to a limited extent the possible value of the submarine in modern naval warfare. It is quite possible that while submarine boats would be of utility to one nation they would not have the same value to another. The most simple method in which to discover the relative value of the submarine to the various nations is to discuss their value to England; in this discussion, if we wish to arrive at any definite conclusions, comparisons with other Powers are inevitable, and so we shall see whether each and every nation possessed of a first-class navy will find it necessary to provide itself with the new arm. The question hinges on whether the policy to be followed in time of war is to be offensive or defensive. Now it is pretty generally accepted that the policy of the British Navy would be for it to go out and attack the enemy. 'The British Navy is pre-eminently a fighting force. It may appear a platitude to say so, for with what object except fighting, it might be asked, does any navy exist? Yet it is true that the British fleet would, in case of war, be called upon to force an action far more urgently than

any other.' [1] 'The military function of a navy is to control the sea, so far as the sea contributes to the maintenance of the war.' [2]

The obvious fact that our Navy must be for offensive purposes, entails the necessity of all its units being 'sea-going.' By this I would not advocate the abolition of what may be called the 'last naval line of defence,' as represented by the old turret ships, broadside and box-battery ironclads, with the numerous semi-obsolete cruisers and slow torpedo-craft, vessels which even the most optimistic patriot could scarcely count in our first line; far from it. These have all had their day, and have, through the mere evolution of time bringing an advance in science necessitating radical changes in structure, dropped out of the front rank, and, where not absolutely *surannés*, are placed under the erroneous heading 'coast defence ships.' But what I do not wish to see is the 'construction' of ships for 'coast defence;' all ships built for the British Navy must have an 'offensive' reason for existence. Nothing could be more disastrous to our Empire than a change from the present 'large displacement'[3] policy, to one of small tonnage vessels of the 'Valmy,' 'Henri IV,' or 'Sissoi Veliky' type. To such a nation as Great Britain it would be a fatal retrogression.

Whilst no such step as the one mentioned above need be feared, I am not so certain whether the policy of the 'offensive' is recognised as the main objective for building all classes of ships constituting our Navy. In smaller craft the 'Powers that be' have for the last ten years shown much hesitation. We stopped building torpedo boats on the advent of destroyers, but three years ago a new start was made with this type of vessel, whilst destroyers seem to have dropped off in popularity with those that sit in high places. And now we come to the main subject under discussion—another section of the mosquito fleet—submarines. Why did the Admiralty order five 'Holland' submarine boats? Certainly not because they want

1 'Naval Policy,' G. W. Steevens, 1897.

2 'Lessons of the War with Spain,' Capt. A. T. Mahan.

3 The present tendency of all nations to increase the displacement would be as fatal if persisted in as a change of policy to small tonnage ships. These great displacements must come, however, in order that the most economical compromise may be discovered; the happy medium cannot be found in a day.

them, for how can they be of use to us in the event of a European War? The only reason that can be assigned for this step is to quell the popular clamour. Six months ago the French submarines were a subject for scorn and ribald mockery —at the reading of the Navy estimates they had already become a threat to our Naval Supremacy. Weird rumours of the impossible doings of the new craft illumined the pages of various excitable organs of the press, and from an object of ridicule, the submarine has become a thing to be feared. This sudden change of sentiment and mutability of nature, forms a true illustration of British insularity.

Now if the people want a thing they do their best to get it, and with reference to submarines—they have them. And having them, of what good will they be? Are they an efficient reply to the enormous French programme of these vessels?

No, they are not. Surely no man, however enthusiastic can imagine a 'Holland' submarine boat accompanying the Channel Squadron on a chase of the French Northern Fleet round the North of Scotland? The idea is absurd, as also the possibility of a submarine engagement between the 'Gustave Zédé' and 'Holland.' Such things are excellent in fiction, but ludicrous to contemplate in practice. Then too, with reference to blockade; the strain on the crew of a submarine for two days is enormous, there being no adequate sleeping accommodation on board. Life on a destroyer is to that on a submarine, as Paradise is to Hades. It is a bare existence, a nerve-shattering, pluck-destroying tension. The 'Narval' was experimentally sunk for 12 hours with her crew; at the end of that time they had to be helped home. And yet we, the nation whose firm intention it is, in the event of war, to take the offensive, build submarines of the 'Holland' type. Pampering to the popular taste is not nice, but when the result of that pamper is nil—well!

We already know the value of destroyers in a rough sea, the 'Cobra' has split in two, and another pair [1] have returned to port with the deck plates buckled; what chance would a submarine have in a similar sea to that which destroyed the 'Cobra?' and yet to be of any use at all to England they

1 The 'Vulture' and the 'Crane'; the 'Seal' has split her deck—the opposite to buckling.

should be capable of remaining off a hostile port for weeks at a time. But whilst the 'Holland' or analogous vessels will be as much a hindrance to us as an acquisition, to neglect the submarine boat altogether would be a fatal step.

America is said to be building two large submersible torpedo boats; Italy, Russia, and Japan are contemplating doing the same thing. Here it would appear is a hint for Great Britain. Large submersible, sea-going torpedo boats, present glowing futures, and there is no doubt but that it is vessels of this type which will eventually develop out of the submarine as we know it to-day. Mr. F. T. Jane in his excellent Annual [1] says, speaking of the French boats: 'Of the above the 'Narval' is probably the boat of the future,' and in this simple sentence he expresses the opinion of the majority of those who have made a study of the subject. For if the 'submarine' will be of but little use to us, the 'submersible' may prove very valuable. In displacement it could excel the destroyer, and so long as it had a good surface speed of at least 20 knots, its submerged speed is a matter of slight importance. Twenty or even many more knots per hour is for to-day in no way excessive. The last 'Nordenfelt' made 20 knots on several occasions, and that was more than a decade ago. If with 20 knots on the surface, such a vessel as I suppose could do 8 knots submerged, there would be no fault to find. Such vessels would prove of the utmost utility to us, especially in the arduous task of blockade.

Coast Defence has lately been receiving a large amount of attention. Dover, Portsmouth, Plymouth, Edinburgh, and other places are having the obsolete muzzle-loaders that for so many years have been a feature of their defences, replaced by modern 6-in. Q.F. and 9.2-in. W.B.L. The placing of these guns on elevated positions such as that of the Dover Forts would make a close blockade by day impossible. By night destroyers could (given clement weather) stand in and institute a rigorous blockade. By day however the value of these vessels is nil, and they would, together with the inner line of cruisers be forced to retire by the fire from the fortifications, which it would be useless to try and suppress. Of the value of bombardment, the Hispano-American War gave us some

1 'All the World's Fighting Ships,' 1901.

knowledge, and we know that for every shot that disabled a gun, a thousand were wasted. It can therefore be taken for granted that places so strongly defended as Gibraltar, Portsmouth, Plymouth, Toulon, Cherbourg,[1] (only lately re-armed), Spezzia, Cronstadt, etc., need fear little from bombardment. If then they are so powerfully defended, how would it be possible to institute a close and rigorous blockade by night as well as by day?

Of course if ships continue augmenting their displacement as rapidly as has been the case during recent years, we may, and in fact should, reach a point when the armour carried by these mastodons would be capable of withstanding the concentrated fire of all the guns of Cherbourg,—no mean battery. But as displacement increases so does the cost of manufacture, and whilst in 1875 we could build a 'Dreadnought' of 10,820 tons for £592,573, to-day it costs us £1,023,600 to construct the 'London' of 15,000, or only 4,180 tons greater displacement. However wealthy a country may be it is quite evident that in time a limit must be reached—it may be that this limit is within sight, it may be centuries off—but a limit there must be. It is quite possible that the continued construction of

1 I had the opportunity some time since (July, 1900) of inspecting the Fortifications of CHERBOURG. The defence against torpedo craft is excellent; no less than 60 large breech-loaders (14 c/m they looked like) are mounted on the breakwater. These weapons, although not of the most modern, could deliver an enormous concentrated fire. The West and East Forts each mounted three large calibre breech-loaders (24 c/m to 34 c/m), whilst four more show two-thirds of their lengths above the battlements of the Fort National. The 14 c/m guns are arranged in groups of five all along the Digue, there being 12 of these groups. Fort de Querqueville mounts several large quick-firers and a number of smaller calibre guns for defence against torpedo attack. Forts Chavagnac, du Homet, des Flamands are, with the ten batteries situated on the surrounding hills, all armed with comparatively modern weapons, and taking it all round, Cherbourg would be as nasty a position as one could wish to attack. BREST is naturally protected by the Presqu' Ile de Kélern, the only entrance being the Goulet de Brest protected on the one side by Forts de Meugam, de Delec, du Toulbroch, and du Portzic, and on the other by Fort de Cornouailles and numerous batteries mounting quick-firers. Protecting the roadstead are Forts du Corbeau, l'Armorique, and Lanvéoc, with the recently modernized defences on the Treberon Islands. TOULON, the impregnable, is in outline not unlike Plymouth, but is far better defended. The great mass of defences of Cape Brun and Fort Lamalgue protect the narrow entrance, the Petite Rade and Rade de Lazaret having efficient protection in Forts St. Elme, Napoleon, Malbousquet, Balaguer and de l'Aiguilette, whilst from the hills behind Toulon, the Fort Rouge and Forts Faron and d'Artigues look after the well-being of the whole roadstead. Perhaps no better placed or protected harbour exists.

such vessels will be stopped by the evolution of some superior and less expensive type of craft, but that is merely a matter of conjecture. What we do know is that no more expensive way of maintaining a blockade could be devised than by constructing invulnerable floating batteries. Besides a new danger has lately arisen to confront vessels told off for the arduous duty of blockade. I refer to the 'Actinaut,' the new controllable torpedo. Even if a ship's bottom could be so constructed as to withstand the charge at present carried by these torpedoes, a slight increase in the size of the projectile would enable that charge to be doubled or even quadrupled, until the most impenetrable armour known to man would be as tissue paper in its power of resistance. Again the weight, should the hull be armoured under water as well as above, would be tremendous, and unless the size is increased to an impossible extent, no vessel could float for the amount of protecting plate; this is obvious, and therefore a compromise must be effected. Can this compromise be brought about through armour plate? I think not, for if a ship's submerged hull could be made by some cunning of the armourers' or constructors' art to withstand even one quadruply charged torpedo as mentioned above, then a second would be despatched, and so on until the work of destruction had been accomplished.

Now there are two modes of defence; avoidance and resistance.[1] Avoidance by smallness of target—the defence of torpedo craft, and resistance by armour—the defence of the battleship. I might have included speed—the defence of the modern cruiser.

But is there no other means of defence by resistance than by armour? Nature answers the question for us. In water we have a means of defence which no gun, be it a thousand times as large and powerful as the Mark IX. 12-in. W.B.L. at present the most powerful gun in the world, could ever conquer. How then can this defence be utilized?

The French were the first to recognise the value of this protection, and gave their first submersible boat the 'Narval' a liquid cushion for protection against shell fire. The 'Narval' being the pioneer of her kind was not the most perfect of vessels, and took nearly half-an-hour to submerge. Four

1 'Essays on Naval Defence,' Vice-Admiral Colomb.

more 'Narvals' were laid down, however, and the 'Espadon' and her three sisters have recently proved their capability of submerging in six minutes—a fifth of the time required by their prototype.

Journalists and others equally at home (?) on the subject of submarine navigation, chuckle quietly as they write down the opinion that before half that time had elapsed, the vessels would be so much scrap iron 'pierced by a thousand well directed projectiles.' Quite possibly, but the third batch of 'Narvals' will no doubt submerge in three minutes, and the fourth order for these 'submersibles' will in all probability contain some such clause as, 'The Government retain the right to refuse the acceptance of these vessels, should the process of submersion occupy a longer period than one minute.'

I really do not think, however, that this question of rapid submersion deserves a quarter of the attention it receives. Take for example a blockade. By night, cruisers will be quite capable of doing all that is necessary, with the aid perhaps of an inner cordon of destroyers; as dawn approaches the submersibles (which have been sheltering under the lee of some friendly battleship, or may perhaps have discovered a secluded cove close at hand in which the crew would find perfect rest), will steam to within the range of visibility for torpedo-craft (different according to the height of the land), and then submerging until just awash, continue their course until within, say, 4 or 5 miles, and at that distance patrol the entrance to the blockaded port. Except in exceptionally calm weather I doubt if they would even be sighted, and should they chance to be seen, it would require miraculous marksmanship to hit a small object about the size of a rabbit-hutch,[1] moving between 10 and 12 knots at a distance of 4 to 5 miles. To find the range even would require no ordinary skill.

But as, according to Admiral Paris, the further we go the more will Naval War be waged with money rather than with men, it would be well to see what this new arm is to cost us. The submarine in France costs now about £14,000; formerly

1 In a submersible such as I propose, the exposed portion would be 34 feet long and 12 feet broad. The conning-tower, which alone would show prominently, has, however, a diameter of only 6 feet, with a minimum height of 5 feet; the simile is not so far-fetched therefore.

it cost £30,000.[1] We are paying £35,000 for our 'Hollands.' A destroyer costs between £45,000 and £50,000. We have then something to go upon, but the diversity of the prices above quoted, is somewhat puzzling. If a destroyer costs £50,000 to construct, a vessel of equal size, with the additional powers of submersion and submarine navigation, would cost somewhat more. But a large percentage of the cost of a destroyer goes in the high-speed high-power engines,[2] whilst no small sum is spent on the armament. All this may be deducted in the submersible; engines of 2,500 to 3,000 I.H.P. would be ample for 20 knots,[3] and of course no guns can be carried, the sole defence (and a very efficient one too) against torpedo boats being submergence and protection by friendly torpedo craft of their side, whilst for offence, being *battleship* and not *torpedo boat* destroyers, the Whitehead is a most reliable weapon. Still as in a submersible vessel there will of a certainty be numerous essential appurtenances not found in a destroyer, I will put the cost at £75,000, and with this price before us, I am sure no one would accuse me of under-estimating. Now the 'London' as remarked some few pages back, is to cost £1,023,000—say £1,025,000, it being very rare for a ship to be built within the contract price. For one 'London' therefore 13 submersibles could be built, and yet leave £50,000 for emergencies. Which would be the greatest bargain, the one or the thirteen? Let me take once more the instance of blockade. It is pretty evident that a port could be more effectually blockaded by eight 'Londons,' six cruisers, and 26 submersibles, than by ten 'Londons,' and six cruisers. As has already been proven, the larger vessels would be courting destruction if they approached close enough to institute a close blockade. With the 26 submersibles, however, two divisions of ten each might be formed, to take over the duty on alternate days. The remaining six would constitute a reserve to relieve any vessels in the organised divisions that happened to break down or meet with an accident. Such work could not be performed by small mechanical toys like the 'Holland.'

1 See chapter on French submarines.

2 4,500 I.H.P. for 27 knot boats, 6,000—7,000 for 30 knot vessels. The 'Viper' developed 10,500, and the 'Cobra' 12,000 I.H.P.

3 In my design I give 500 I.H.P. for 14 knots for 250 tons displacement.

These submersibles must be vessels of between 250 and 350 tons with accommodation for some 35 to 40 men, instead of the miserable five or six who will form the crew of the Vickers-Maxim boats.

But whilst decrying the 'Holland' for nations such as England (of which indeed there is but one), they are as a type of defensive weapon as much in advance of the Orling-Armstrong, Brennan, and other torpedoes, as these latter are an advance on the Whitehead.

The French 'Perle' class would be a veritable pest to any blockading fleet, in that it would not be safe thirty, forty, or even fifty miles from the land, in any but very rough weather. Within their sphere of action these submarines—note well the difference between 'submarines' and 'submersibles'—would prove of immense utility. They would not be required to make long sea passages or cross oceans—that is not their work. But they could make it decidedly unpleasant for any over officious vessels coming within the zone of potency, which may be put between 75 and 100 miles. The presence of submarines in a harbour however, in no way reduces the efficiency of submersibles for blockading any larger vessels there may also be shut up. Submarines cannot fight submarines, and although it is possible that such craft might meet by accident, and a mutual discharge (and probably waste) of torpedoes ensue, to go looking for vessels of their own type for the purpose of destroying them, would be seeking for a needle in a haystack, a useless waste of valuable energy. It can thus be taken for granted that any fleet blockaded in a harbour by a Power possessing large submersible vessels, will, unless its commander is a raving lunatic, remain quietly at anchor—to leave under such circumstances would be to risk an almost certain repetition of Santiago. Some at all events of the escaping fleet would succumb to the torpedoes of the blockaders, and the flurried remnant speeding swiftly in all directions in an agony of apprehension, would have to encounter the outer circle of large vessels, consisting of battleships and cruisers. Yet, for all that, the advent of the submarine has doubled the cares of the blockader; the torpedo-boat was a menace, but the submarine is a very vivid danger. And too, the value of the submarine is all on the side of the weaker Power. That

it militates to a certain extent against Naval supremacy is undeniable. Earl St. Vincent having heard that Pitt was encouraging Fulton with all the means in his power, said on hearing the result of the well-known 'Dorothea' experiment,[1] 'Pitt is the greatest fool that ever existed, to encourage a mode of war which we, who command the seas, do not want, and which, if successful, would deprive us of it.' But what is more important is that our possible enemies grasped the truth of this statement, and saw their advantage even more clearly than did Earl St. Vincent. The continuous researches made by France and Russia (Germany having only recently come into being as a Naval Power) from the time of Fulton up to the present, shows plainly that these countries recognised our superiority in the 'human element;' the advent of a scientific age would place all nations more or less on a par.[2] No such equation as 'one Englishman is equal to two Frenchmen, and one Frenchman is equal to two Spaniards and a Portugee' holds good in the present day; the human element is of course even yet of the utmost importance, but in a different way—then it was strength of arm and mighty thews which won England's battles; to-day it is coolness, quick-judgment, keenness of eyesight, and above all, stamina. Machinery, guns and armour have taken the place of brute strength, and as there are very few occasions in history on which cowardice could be imputed to our enemies, we must consider that in the battles of the future, our opponents, whosoever they may be, will stick to their guns and die fighting as we all know our own gallant sailors have ever done, and always will do.

1 Pitt caused a stout Danish brig, the 'Dorothea,' of 300 tons, to be anchored near his country seat at Deal, and this Fulton, after repeated experiments, succeeded in destroying on Tuesday, October 15th, 1805, with a torpedo containing 170-lbs. of powder. A journal of the period, commenting on it, said:—'This occurred in the presence of a large concourse of spectators, amongst whom were the commissioners and a number of naval and military officers of high rank, one of whom, Captain Kingston, loudly asserted, a few minutes before the 'Dorothea' was blown up, that 'If one of the machines were placed underneath my cabin while I was at dinner, I should feel no concern for the consequences.'' This gentleman must have felt somewhat discomforted at Fulton's success.

2 Vice-Admiral Jurien de la Gravière once said: 'Toute invention qui menace les colosses et tend à emanciper les moucherons est un progrès dont la Marine française ne saurait trop s'emparer, car il n'en faut pas plus pour doubler, en quelques années, ses forces et sa puissance.'

Whilst discussing the human element, it would not come amiss to say a few words relative to the moral effect of the submarine on the crews of vessels engaged in future naval battles. Anyone who has had the opportunity of standing on the deck of a battleship or cruiser during the manœuvres, on a dark moonless night, with perhaps a fog or drizzling rain, will know what it is to have an involuntary shiver run down the spine. 'Oh, no, I'm not cold, thanks,' you say to the whispered inquiry of an officer who has noticed the shaking of the oilskins. This is the true nervousness; no one speaks above a whisper, everyone is straining their eyes to try and fathom the impenetrable blackness of the night, and every few minutes will come a sharp exclamation from one or other of the watchers who thinks he sees what is not there—or maybe it is the white crest of a wave. Imagine this—many of my readers must have felt it and such will know that I do not exaggerate—and then replace torpedo boats by submarines, vessels of which the conning tower alone is visible even when sighted, and which in daylight might pass within a hundred fathoms of you with impunity! The nervous tension brought about by this constant watching for the invisible, and the continuous waiting for that which does not come, is unbearable. I know for a fact that even during the manœuvres such as the French delight in carrying out with their submarines, the sailors on the ships awaiting attack are in a fervid state of nervous excitement and tremulous anxiety—are, indeed, filled with a secret dread of the mysterious. This strain on the nerves would be so great when the 'real thing' is being enacted, that sleep would be an impossibility, and, except with crews of the very highest moral training (and there is happily every reason to believe our own men to be such[1]) in a short time, crews which had once been second to none, become little better than nervous worn-out wrecks. We know the state of the Spanish sailors of Cervera's ill-fated fleet, and their inability to fight, owing to the continual expectation of the order to go out to certain destruction; the action of the Chinese in the various torpedo boat attacks made on them by the Japanese in Wei-Hai-Wei Harbour is too much a matter of history to bear

1 The morale of our sailors is equalled by no other nation, unless it be the Germans.

repetition. Of course such conduct is happily not to be expected from the sailors of a first-class naval power—still the submarine will have a great moral effect on the bravest of men. Every sailor is by nature superstitious, and if you only persuade him long enough, you can even make him believe in the sea-serpent. Colonel V. Cuniberti, of the Italian Navy, told me that he did not consider a submarine boat really needed torpedoes. What he would do if he had one, he said, would be to get as near a hostile fleet as possible and make one or two dashes to the surface, until certain that he had been seen. The moment the enemy's Commander knew of the presence of a submarine boat he would undoubtedly turn tail and fly. 'Of course,' the Colonel added, 'she might carry torpedoes in case of necessity, but I don't think they would ever be needed.' Here we have a well-known expert advocating the presentation of the submarine to the full view of the enemy, and endeavouring to win the day by frightening him. There is much truth in this theory, and I am sure that very few of our Commanders, ignorant as most of them are of the capabilities of the modern submarine, and possessing as they do the universal opinion that they're all d——d rot, would not, if they saw a French 'Perle' or the 'Morse' do a porpoise-dive or two close at hand, stop to make inquiries as to the health of the occupants or the speed of their boat. This seems of course to be developing into a Celestial method of warfare, for it will be remembered that just before the battle of the Yalu, the Chinese sailors were observed to be making faces at the approaching Japanese fleet, with intent to scare them. But enough of the moral effect.

To return to the submarine as a weapon of the weaker power, the first thing that strikes one is its price. The French manage very well on £14,000 to £15,000 apiece, but even if we allow them £20,000 for the construction of each vessel they will yet build 71 submarines for the price of one battleship.[1] The economy in this for a comparatively poor country is evident, but it is hardly fair to draw comparisons between the submarine and the first-class battleship. The latter must

1 The 'Republique' class are to cost £1,421,708 each. The 'Suffren' cost £1,195,564, the 'Jena' £1,111,340, the 'Bouvet' £1,100,770 and the 'Masséna' £1,100,400 ('Brassey's Annual').

for many years be the main factor in naval warfare, and any country renouncing the construction of such vessels resigns its position as a first-class Naval Power. It is with the coast defence ships rather that submarines should be compared. France has the 'Tréhouart' and 'Bouvines,' each of which cost circa £595,000, the 'Valmy' built at a price of £578,000, the 'Jémappes' costing £525,000, and the 'Henri IV.' about £800,000; Russia has the two 'Sissoi Velikys' costing the same as the 'Henri IV.,' and the four vessels of the 'Admiral Oushakoff' class, which have cost about £410,000. Germany has the 'Heimdal,' 'Aegir,' and 'Odin,' which cost £233,500 each, the 'Hildebrand' and 'Hagen' costing £218,000 each, and the three 'Siegfrieds' which cost about £175,000. It will thus be seen that France has recently spent £3,093,000 on coast defence battleships, Russia £3,240,000, and Germany £1,661,500. For these sums, Germany could have had 83 submarines of the 'Perle' class, or 22 submersibles, such as I described above; France might now be in possession of 154 submarines, or 41 submersibles, and Russia would be the owner of a gigantic fleet of 162 submarines, or 43 submersible torpedo boats. The distribution of these fleets of submarines round the coasts would make the harbours of the Nation possessing them absolutely safe. It is a common practice to jeer at the submarine on account of the little it can do, but if the number of submarines be multiplied, that little becomes a lot. The submarine is like the wolf, ever ready to attack, but when single and not supported easily driven away; if however, there are a number, the possible support one may give to the other breeds confidence, and then,—*en garde!*

There is another use for the submarine, and this is one of the few instances in which the submarine may prove of value to England. If a cruiser appeared before a town such as Torquay, Yarmouth, Havre, Cette, Naples, Brindisi, and started bombarding that town, it would in the course of its bombardment have cause to zig-zag to and fro across the bay, or harbour, bringing each broadside to bear alternately. Now if a couple of submarine boats were kept constantly stationed there they might make slowly out to sea in a direction opposite to that in which the cruiser is going, and wait till that vessel returned and crossed their bows. Let me explain further. If a

cruiser A is steaming E. and W., bombarding a town in the S. direction, then when the cruiser has turned at the eastern-most branch of its zig-zag and is steaming W., the submarine boats will leave their mooring and steer a N.E. by E. course, which would bring then on to A.'s line of action. This manœuvre effected, they would await the cruiser's approach, and when opposite them fire their torpedoes and diving, make away back to their moorings. It will perhaps be remarked, 'Ah, yes, but look at the number of submarine boats we should require?' Not at all;— firstly, we, England, should not require any, whilst the towns of France, Germany, Russia, Italy, Spain, which you will, worth the waste of shot and shell necessitated by a bombardment, could almost be counted on one's fingers. Let us take France, and, starting from the north see how many towns would be likely to attract a hostile cruiser. There are Dunkirk, Calais, Boulogne, Dieppe, Havre, Quimper, St. Nazaire, La Rochelle, Rochefort, Bayonne, Biarritz, Cette, Palavas-les-Flots (the ancient port of Montpellier), Marseilles, Cannes and Nice. Sixteen, all told, and at most of these any ambitious cruiser would get as much as, if not more, than she could give. St. Nazaire, Rochefort, and Marseilles are especially strongly fortified, and Cette, a quiet unpresuming little trading town would not be worth the waste of ammunition. A bombardment of Boulogne, Biarritz, Palavas-les-Flots, Cannes and Nice, in the season, would be the murdering of many inoffensive trippers, and out of the season for the first three places, it would mean the destruction of a number of empty lodging-houses and hotels. But even without deducting one of the number named, less than half of the submarine fleet at present building or projected in France, would supply each township with two protecting sub-aqueous craft. I might have added Ajaccio and Cagliari, but they both have so much in common with Cherbourg and Toulon as regards defences, that no Commander would think of risking his ship by their bombardment.

Italy has more sea-coast towns, but as I happen to know that the future policy of Italy is certainly not in submarine boats, nothing need be said about them and their defence. What has been said of France, applies equally well to Germany and Russia. To the smaller States the submarine may hold out a

future, but as no one is likely to quarrel with them, and any desire on their part to quarrel amongst themselves will be promptly suppressed by the inevitable 'European Concert,' it really matters very little what their policy with reference to the subject happens to be.[1]

A word more on harbour defence. There are certain harbours belonging to certain powers whose very best defence would be the removal of the mark buoys; not only would any hostile vessel endeavouring to approach most certainly run aground, but even the country's own vessels would be unable to enter. One harbour I have in mind, a naval port, is specially favourably endowed by nature in this way.

Another use to which the small handy submarine, such as I imagine the 'Perle' class will be, is that of vedette boats. They would be carried on the decks of battleships just as several of our vessels now carry second-class torpedo boats.[2] The great difficulty in this, however, would be in launching them. Anyone who has witnessed the launching of a boat in an even comparatively smooth sea, but with a long rolling swell, will understand where the difficulty lies. With a submarine it is apt to be augmented, for whilst a boat has always a large amount of buoyancy, the buoyancy of a hollow shell, a submarine boat placed in the water has but the slightest reserve of buoyancy enough to ensure flotability, and the downward roll of the iron hull of the mother ship might conceivably drive it under water and stave in the conning tower, or dent the hull. Still, means may be evolved for the safe launching of a submarine at sea, and it is quite possible as Sir John Hopkins says, that in a short time no battleship will be without a pair of small submarines. Their value in a fleet action, given calm weather (for it is right to expect good as well as bad) would be enormous, and their presence might perhaps turn the day in favour of the side to which they belonged. What would happen if two opposing fleets each launched a dozen or so submarines before going into action is too awful to contem-

1 In war time, no doubt, many of our sea towns would implore protection; this could be provided by apportioning our old Reserve vessels such as 'Superb,' 'Sultan,' 'Dreadnought,' for the defence of the most important towns. These vessels, although unable to lie in line, are perfectly capable of beating off one or even two hostile cruisers.

2 See Admiral Sir J. Hopkins' article.

plate; a veritable holocaust would result. As the torpedoes hit their mark and exploded, the riven battleships would sink, probably drawing down several of their tiny tormentors in the vortex. Such warfare is not pleasant to contemplate, yet war is the arbitration of blood, and whilst there is war there will be bloodshed, whether it be by feathered shaft or steel covered bolt. It was said that the advent of the magazine rifle and Maxim gun would increase the bloody nature of war, and yet from the experience we have culled from the late war in South Africa, the battles of to-day are not anything like as sanguinary as those of a century ago. A simple reference to the statistics of the Crimean war, or the famous Waterloo, or more recently the Franco-Prussian war, will bear out this statement. Disease is the most potent factor in modern warfare, and although this will not be the case on board ship, it is to be hoped that the mortality will, as with land fighting, decrease, as weapons improve. We know, however, the tremendous loss of life resultant on the accidental ramming of the 'Grosser Kurfurst' by the 'König Wilhelm' on May 6th, 1878,[1] and the 'Victoria' by the 'Camperdown' on June 22nd, 1893;[2] on the sinking of a ship during action there will be very little hope for any of the crew; the boats, if carried at all, will indubitably be like sieves, and incapable of remaining afloat for more than a few moments.

It will have been seen by now that a far greater difference exists between the 'submarine' and 'submersible' than is generally recognised. The submarine is a 'defensive' instrument; the submersible is an 'offensive' instrument. I hope also that it has been conclusively proved that England does not require submarines. But whilst submersibles are the arm for one country, and submarines the weapon for another, there are cases in which a nation should possess both; as instances of these I might mention, France, Germany, and the United States. In a war with England these Nations would require 'submarines' for they would evidently be in the position of the weaker power. But if one or other of them were engaged in a war with Italy, Spain, Austria, or even Great

1 281 were drowned, and 3 died from exhaustion.

2 321 officers and men lost their lives, including Admiral Tryon.

Britain as the attacking Power, they would find submersibles more useful. Take France as the most important example.

We all know that it is France's dearest wish to plant her army corps on the shores of perfide Albion, but our superior fleet effectually bars the way. This fleet, however, might possibly be decoyed on a wild goosechase (such things are by no means unknown to history) and voila! A hundred merchantmen appear off some isolated part of the coast and pour out their 150,000 well equipped, good and true followers of the tri-colour. Debarkation however, is not effected in an hour, and it is more than probable that before it had been completed the decoyed fleet, notified of the trick, will appear on the horizon, and will be met by a cordon of submersibles. Now it would be decidedly discouraging to a Commander in such a predicament to know that an advance meant possible annihilation, and to remain where he was, the landing of the invader on his native shore!

Some enthusiasts amongst our neighbours d'outre Manche, even propose transporting the invading force in submarines! This is no novel idea, having been proposed in 1800 to our redoubtable opponent of that period by Fulton. It is not for me to discuss methods of invading England; the great Bismarck once said he knew of thirteen ways of getting here, but not one of getting out again. Perhaps the French idea of utilizing submarine boats is a fourteenth plan of invasion.

Now as to our probable future policy, unfortunately for all matters relating to the defence of the Empire, England is never sufficiently long beneath the influence of a single set of minds to carry out a perfect scheme of preparation for war in its entirety. Many such schemes have been evolved, but by the time estimates for their execution have been fully developed a change of Ministry or similar inopportune occurrence takes place, and the project falls through, is pigeon-holed by a junior clerk, and is resuscitated several centuries later to be published as a brochure by the Naval Records or some other Research Society. Such has haplessly been the fate of many worthy plans, whilst others, as absurd as they were unnecessary have been carried through to the bitter end. Two typical instances of this ill-starred system are the 'brick and mortar' policy, resulting in the foundation of a scheme of

coast defence, remnants of which still exist in the 'Martello' towers scattered round the coast, and the policy which rejected breech-loading guns when once adopted, in favour of the erratic and obsolete muzzle-loader. What has been the result of these foolish whims? Millions and millions have been spent on forts, which at the time of their conception were out of date, and England alone of all the Great Powers still includes vessels mounting muzzle-loading guns as part of her effective fleet. The recent addition of a very energetic Financial Secretary to the usually dormant staff of the Admiralty has gone a long way to remove this disgrace; since Mr. Arnold Forster has been in the position he at present fills, a dozen or more ships, retained formerly to swell the total, have been struck off the list of effectives. The old forts too, with their picturesque 9-in. and 10-in. muzzle-loaders are rapidly being dismantled, batteries of modern weapons being mounted in their stead.[1] All this modification and rearmament would not be necessary, however, had the forts not been built in the first place. Anyone who has sailed around the coast will have noticed these forts, and will have remarked what fine targets they present. Batteries such as are being erected to-day are quite invisible, consisting as they do of nothing but a grass mound, through a channel in which the muzzle of the gun protrudes.

But whilst to err is human, to forgive is Divine, and the people in their treatment of their misguided administrators have gone some way towards that state of blessedness. Their complacence on the subject is mostly, if I dare venture the remark, due to their ignorance thereof. Admiral Colomb once wrote that 'History is often allowed to sway us in one way, when, did we adopt its real teachings, it would show us that the way was a treacherous bye-path.' Substitute 'the Admiralty' for history and we have a modern truth. If that august body says the submarine is useless, then to Parliament and people alike, it *is* useless. If they hinted that a return to the old wooden three-deckers seemed advisable, I verily believe a number of persons would applaud their intention. To

1 At Sandown, I. of W., a battery of three 6-in. W.B.L. has been placed between two old stone forts mounting 10-in. M.L. The policy of this is easily comprehensible. Any ship being fired at from the battery would reply at the brick forts; these latter are visible, the battery is not.

feel confidence in one's rulers is to add to the consolidation of the Empire, but there is no reason why we should not endeavour to discover whether that confidence is well placed. The tame reception of the Naval Estimates every year is a good instance of the *laisser faire* policy adopted; even the debate thereon is unworthy of the name. Some truculent 'anti-everybody' may perhaps get up and propose that the wages of the whole staff of Whitehall be reduced one half,[1] but there the matter ends. It seems strange that the 'Committee' method of settling our naval requirements is not more frequently resorted to, perhaps the result of the 1888 Committee has not yet been forgotten. A systematic reorganisation of the various departments might be tried, but I fear when the twentieth division had been roused to its proper state of intellectual brightness, the first five would again have succumbed to hypnotic influences and languid drowsiness. It is like one man trying to move a mountain; whilst removing it he is building up another mountain behind him. We have one reason for satisfaction; a very poor satisfaction it is true. If our organisation is not good, nor is that of other countries. If everything were perfect, we should exist in a Celestial Utopian atmosphere, each patting the other on the back and remarking on his own and his friend's perfection. Still perfection being the top-most rung of the ladder of inextricable confusion, there is no reason why we should not be a few rungs nearer it than our neighbours.

TACTICAL VALUE OF SUBMARINE BOATS.

By X——

In arriving at the opinion as to the tactical value of these vessels, their limitations and capabilities should be carefully considered, and the order of their fields of usefulness determined as nearly as may be with no results of their use in action to aid in reaching a determination.

1 A rumour of such a proceeding would be useful as a revivifier; any members so affected would know that even if their wages were halved their work could not be, and seek consolation in this obvious fact.

Taking into consideration their peculiar qualities as fighting machines, it would seem that they would prove most effective:—

1st. In holding the first line of coast defence, *i.e.*, a line just outside of bombardment range.

2nd. In harassing and, if opportunity offered, in sinking blockading ships, and thus preventing a close blockade of any port defended by them.

3rd. In holding channels and narrow waters against a fleet attempting to enter.

4th. In carrying communciations through hostile lines.

5th. In fleet operations in company with ships in or off shore.

6th. In the clearing away of torpedo mine fields and other marine obstructions.

7th. In the reducing of a place defended by armoured ships, torpedo mine fields, marine obstructions, torpedo boats, dirigible torpedoes, torpedo batteries, and shore works located within moderate range of at least four fathoms of water.

In this paper the boats considered will be assumed to possess only the speed, endurance, and radius of action of the one now building for the navy, and no allowance will be made for the probable increase of these in the near future. At present these are:—

Speed, surface, 16 knots.
Speed, submerged, 8 knots.
Radius of action, surface, 1,000 miles.
Radius of action, submerged, 60 miles.

But in armament there will be assumed a change from the twin torpedo tubes of the present boat to a fixed torpedo tube in the axis forward, an elevated torpedo tube or pneumatic gun aft, and an elevated pneumatic gun installed above the axial torpedo tube forward. This last gun might be omitted for the first five uses mentioned above, but would be very necessary for effective work in the last two, and would be useful in all.

The method of driving home an attack on a ship would be the same in *all* cases where the depth of water was suffi-

cient for the boat to pass under her keel, and would be as follows:—As the boat and ship drew together under any of the conditions hereafter treated, and the fire of the latter grew hot, the boat would drop from the light to the awash conditions, and thus present but a small target for gun fire, and could well sustain a few shot through her smoke-stack, since there is ample room for the housing of a punctured stack. If under these conditions there were a lack of torpedo destroyers or other light hostile craft to force her to dive, she would have a very good chance of closing to within 1,500 yards of the ship, in which case she would toss aboard the ship a one hundred and fifty pounds aerial torpedo from her bow gun. There would be a fair probability for effective work, because she would have the ship always in sight and the distance measured. She would still be beyond the ship's torpedo range, and, from the small target she would present, would have little to fear from gun fire. She might even practice against oncoming light craft, especially if these last were charging her in a group, but her legitimate rôle would be to pay all her attention to the big ships, and avoid the small ones. When a shot or two through her stack intimated that the enemy were getting her range, she would out fires, douse stack, seal up, head so as to intercept the ship's course, dive, and make a run at five fathoms below the surface of about 500 yards, and then rise till the top of her turret or that of her camera-lucida tube above water gave a view of the enemy and the consequent direction for the next submerged run. During such an approach the ship's torpedoes would be useless, because the boat presents too small an object for torpedo practice, because her torpedoes if adjusted for use against surface vessels, would pass harmlessly over the boat when she was at her running depth, and because their chance of striking while the boat was rising or diving is too small to consider, even if her course could be followed from the ship with sufficient accuracy for laying the torpedo tubes, which last would not be possible.

Gun fire would be employed against her, but the chances of its proving effective are hardly worth considering, when it is remembered that she would present as a target only a few square inches of armoured turret, or the top of her camera-lucida tube for a few seconds at a time in unexpected and

impossible-to-predict places. A very lucky plunging shot from a battleship's top, delivered just as the boat rose, would be effective, but it is to be remembered that the swaying of a ship's top in a seaway makes any fire from aloft inaccurate, and that a plunging shot has absolutely no danger space; *i.e*, the shot must go directly home, with no chance for a hit, due to the fact that it is flying nearly parallel to the surface of the water, above which the object stands in the case of gun practice against ordinary vessels. The small chance of disaster due to gun fire would certainly not be enough to deter, when escaping it would mean the defeat of 500 men in an expensive battleship by five men in an inexpensive boat.

When the boat arrived within 300 yards of the ship she would make her final dive, deliver her bow torpedo from her axial tube, pass under the ship if her direction were good enough—and at such close quarters she could hardly miss—and as the light through the water gave notice that the ship were passed, the stern torpedo would be delivered against the ship's hull well down to her bilges. The attack could always be avoided by the ship's steaming away at speed, for the boat could not chase submerged for any length of time faster than eight or nine knots, though she could make short runs at 12; but if the boat chased the ship away she could be considered to have given a good account of herself.

If the commander of the ship, in view of the futility of his gun and torpedo work, should resort to the desperate expedient of attempting to ram the boat, he would greatly aid the latter; for she could reach a safe depth below the keel while the ship were moving a length, and thus gain the best possible position for delivering a shot from the stern tube.

Since the chief duty of the boat is to get into the course of the ship, it is evident that ramming tactics would only help the boat to make her attack easy and effective; for the most difficult thing she has to do is to get under the ship, since there is absolutely no lookout ahead when running submerged, and consequently no certain indication that she is going right until the dense darkness followed by a murky light shows that she has crossed the ship's course.

A Holding the First Line of Coast Defence.

The length of the line that it would be desirable to hold off any coast town would, of course, depend upon the length of the front determined by the contours of the coast line, outside the zone held by shore defences, and inside bombarding range, along which a hostile fleet could operate.

The length of line that it would be possible to hold would depend upon the number of boats available, stationed at practicable intervals from each other.

The greater the number of boats the farther out could a continuous line be carried; the fewer the boats the nearer in if continuous, or the shorter if carried out, would be the line.

Having determined the front along which a hostile fleet could deliver an effective fire the boats should be stationed on it and arranged to meet the most probable movements of the enemy.

Against a place provided with any serious defences, and especially against a place defended by submarine boats, the most effective way for a fleet to operate is the well-known one of 'circling,' *i.e.*, steaming past the point of attack at speed in column of vessels, the leader hauling out of range after her fire is delivered, and circling back to renew the attack, and her motions being followed by the other ships in succession.

The chief reason that makes this method a favourite one among tacticians is that it enables the attack to be made at speed, and therefore renders the ships quickly moving targets, while it does not prevent, that most difficult thing to attain in naval warfare, an exact knowledge of the range, and a consequent accuracy of fire; because the range can be determined, and the guns laid beforehand and the fire accurately delivered when the sights are brought on by the ship's reaching her predetermined firing position.

To meet such an attack the submarine boat flotilla should anchor along the bombarding line at intervals depending on its strength, and lie there, in the light or awash conditions with smoke-stacks up and steam ready, in all weathers in which a hostile fleet could make efficient gun practice, receiving reliefs of crews and supplies of fuel and other stores

as might be necessary from a fast tender, preferably of the Torpedo Destroyer type.

Although the general principle that 'the closer the interval the stronger the line held' applies to submarine boats, it is to be borne in mind that dissemination for them does not have the obvious features of bad tactics that it has for surface vessels, which, when scattered, offer the enemy opportunities for concentrating upon weak points and defeating the whole force in detail; for the greater the number of ships that would concentrate upon a single unsupported submarine boat the better would be her chance of striking home from below the surface.

Under the conditions outlined above, the duty of the submarine boats would be as follows:—Supposing, as is most probable, that the hostile fleet reaches the defended line at one extremity standing in in column of vessels.

The boat nearest the approaching fleet would, as soon as the enemy were made out—and it is to be observed that she could make out the fighting tops of a battleship on the horizon much easier than the ship's lookout could locate her—douse her smoke-stack, sink to the awash condition, and await the approach of the ships. If light Torpedo Destroyers were sent on ahead she would haul below the surface, leaving only her camera-lucida tube above water. In this position she would present a target almost impossible for the on-coming light ship to strike with a torpedo; but in case the enemy's torpedo practice were considered dangerous, she would only have to haul down below the plane of the torpedoes' path to be out of danger; this she could readily do in order to hold her position in the course of the approaching ships, rising to the surface for a few seconds, now and again, to watch the progress of affairs.

The other boats would observe the direction of approach of the hostile column, and if it coincided nearly with their own line they would hold their positions in the same way as did the first boat.

If the direction of approach was outside or inside the line they were occupying, each boat independently would weigh and steam slowly, in the awash condition, in a direction at right angles to this line, so as to place herself in the course of the

approaching ships, and then douse smoke-stack, seal up, and keep only the top of her turret above water. The one paramount duty of each boat acting independently of her consorts would be to place herself in the course of the approaching ships. Torpedoes could not drive such boats from their stations, gun fire would be useless, and the admiral who would take his fleet such a line for the sake of bombarding a town would do so only under the demand of most desperate conditions, and would have to endure the enormous strain due to the moral effect of well-known but unseen danger.

But suppose such chances were accepted by the enemy. The first boat would wait till the leading ship closed to 1,500 yards and deliver the attack as before described.

As soon as her attack was delivered and her torpedo tubes reloaded, the boat would raise her turret top or lucida tube above water, select the nearest antagonist and drive home her attack as before. All the ships that escaped the attacks of the first boat would have to receive those of the other boats in line or haul out of action,—an expedient that would increase in attractiveness with the number of boat attacks driven home. Under such conditions the attempted bombardment of the defended town would be quite harmless for defenders, and exceedingly expensive for the attacking force.

In case the attacking fleet abandoned the range advantages of the circling tactics and charged straight up in line, each boat would select her ship and stop her by torpedo work as in the last case. Ships that passed the line of boats would be followed in shore, and the chances of their ever being able to haul off would be small if the number of boats was equal to that of the ships.

B. In Breaking a Close Blockade.

It is apparent that if blockading ships can be forced sufficiently far off shore, blockade runners can evade the fleet and enter or leave the invested port.

In order to most effectively break a blockade, the number of submarine boats should be equal to the number of ships. The tactics would be extremely simple, since the only point

for the commanders of the different boats to bear in mind would be for each to sight the ship he was detailed to follow and stick to her until she was at least fifteen, and at most twenty, miles off shore.

These distances would be sufficient for the escape or entry at night of fast merchant blockade runners, or for what might be vastly more important, the freeing of a fleet shut up by a superior force; for what fleet the defenders had could be most usefully employed in striking the enemy's weak points,—concentrating on his exposed flanks, demonstrating against his base, or cutting off his lines of supplies, for instance.

Again, these distances are determined by the submerged radius of action of the boats, since they might have to work in the sealed up condition for the whole time they were forcing the blockaders back; certainly would, if, as may well be supposed, the enemy's admiral protected his ships with accompanying fast Torpedo Destroyers, and was cool enough to stand off at a speed only a little in excess of that of the boats running submerged, and would thus compel them to be always ready to render futile his torpedo and gun work, and to drive home an attack.

If at fifteen miles from the bombardment line the ships doubled back and steamed in at speed, the twenty-knot ships would arrive there fifteen minutes before the boats; and although it would only be the enemy's fast cruisers that could accomplish this, it would not be prudent to give them more time there, unless there were reserve submarine boats left behind to receive them.

Sixteen-knot battleships alone could be forced farther off the coast; for if they doubled back the boats would up stacks, light fires, and follow them in, arriving on the bombarding line in time to prevent any effective work at bombarding range.

C. Holding Channels and Narrow Waters Against a Fleet Attempting to Enter.

In this case the duty of the boats would be practically the same as holding the bombarding line. But the line would be shorter and therefore more easily held, and the boats intended

for this purpose alone could be smaller than those that had outside work to do. Since their radii of action would be short, they would need steam neither for covering distance nor for renewing their electric batteries, as these last could well depend upon a shore base. In fact, boats for this purpose could be made as small and of much the same general type as the 'Goubet' boats now built in France, small enough for convenient transport by rail. If the channel to be defended were too shallow to allow the ships to pass over the boats, these last would have to avoid possible ramming by heading out all the time, and then avoiding the advancing ship's ram and propellers by a little use of the helm. Under such conditions it would be almost impossible for the ship to strike with her ram, while the attempt to do so would give the boat an excellent chance for getting home her torpedoes.

D. Carrying Communications Through Hostile Lines.

This would be an extremely simple matter, for the only thing the boat would have to do would be to avoid being seen by making long submerged runs.

If it were necessary to communicate in daylight, it would be well for the boat to work up to about three or four miles of the ships with only her camera-lucida tube above the water, then dive and run fifteen or twenty miles on a compass course, at the end of which she would rise, get a look around, and if there were no fast hostile ships in sight, up smoke-stack, light fires, and steam to her destination, anywhere within a thousand miles. If on rising she made out a Torpedo Destroyer she would again dive and run fifteen miles in a direction at right angles to the one she had come out on, and thus probably avoid any ship sent to look for her. If the circumstances were at all favourable she would stop pursuit by sinking the pursuing ship.

In case the enemy had a very great number of fast craft that he could spare to hunt for her, and in case the necessity for communication were so great that she could not spend time to attack pursuing ships, it would be better for her to run out

at night, when her under-water run would need to be only long enough for her to pass outside the range of the enemy's search-lights. As soon as she passed them she would up stack and steam on her way.

E. In Company With Ships in or off Shore.

Owing to their capability of taking the sea over all, they could, when running light, keep position with a fleet better than can the ordinary surface boats; they would be easier in their motions, and in that respect less fatiguing to their crews.

With supplies of oil, fuel drawn from the ships as required, and with necessary relief of crews, these boats could be relied on to accompany the fleet in any off-shore work when surface torpedo boats could be expected to keep company.

When, in a general engagement, a torpedo attack were desired, the submarines could be confidently sent in from the shelter of the fighting ships, for they would have nothing to fear from the fire of hostile guns, since they would have effective water cover when running with their camera-lucida tubes only above the surface; nor would their movements cause a slackening of fire from ships of their own fleet by their occupation of the fire-swept zone, since they would be equally as well covered from accidental hits from friendly guns as from hostile fire. In this case surface boats could not annoy them or force them to dive, because no surface torpedo boats could live a minute in the field of fire between engaging ships or fleets.

It is difficult to over-estimate the aid that a well-handled submarine-boat flotilla would give to a coast-defence fleet, weak in numbers, standing out to engage a strong investing fleet unaccompanied by one; for the side that could drive home a torpedo attack through the cross-fire of friend and foe would most assuredly possess an enormous advantage.

F. Clearing Away Torpedo Mine Fields and Other Marine Obstructions.

If the general direction of the mine electric cables were known a submarine would be sent in to drag along the bottom,

grapple the cables, cut them, haul in the cut end and explode the mines. But if the location or direction of the cables could not be learned, or if for any other reasons these could not be dragged for, a position within the submarine's pneumatic gun range of the mines would be selected from the observing ships and the boat sent in to occupy it by running awash. Arrived on the predetermined position the boat would practice on the mine field by firing aerial torpedoes. Since pneumatic guns are very accurate when the range is known, it would seem that from a predetermined position the aerial torpedoes would be delivered in the mine field when the guns were pointed by merely heading the boat on a compass bearing, and that therefore the fire would be effective in exploding the mines.

The boat might anchor on her position and rise to the surface to deliver a shot, and then haul below the surface. The chance of putting her out of action by the fire of any mine covering batteries would be very small, for the target to strike would consist of a few inches of armoured turret exposed for a few seconds.

Booms and floating obstructions of all kinds, with their moorings, could be attacked in the same way with good chance of success, and if, as would be probable, the booms were defended by mines it would be more effective than in any other way. Sunken obstructions in a channel would be located by a submarine boat feeling up to them, and then attacked by torpedoes.

Such an attack would smash up hulks, and perhaps with the aid of tidal current clear the channel.

Well-placed, unfloatable, sunken obstructions of sufficient bulk cannot be removed by torpedo work, or in any other way short of regular mining and dredging operations that can be carried on free of hostile interruptions.

G. The Reduction of a Place Defended by Armoured Ships, Torpedo Mine Fields, Marine Obstructions, Torpedo Boats, Dirigible Torpedoes, Torpedo Batteries, and Shore Works Within Moderate Range of at Least Four Fathoms of Water.

As in other cases cited, the usefulness of submarine boats for this purpose is due to the fact that they can in the covered or submerged conditions effectively operate in a zone of fire untenable to anything but the best of armoured ships, and when so operating evade instead of receiving hostile fire.

Against armoured ships assisting in the defence of a place and outside the torpedo mine field and marine obstructions, the submarines would attack as has been described for attacks on ships; except that if the ships hauled in shore in shallow water so that the boats could not pass under them, the torpedoes would have to be delivered from the bow tube alone, and the attack renewed until it was effective. On the other hand, the ships, being in shore and having to stick to their defending stations, would consequently be deprived of their chance of avoiding attack by standing off shore at speed, as could blockading vessels.

If the ships were inside, and the contact makers of the torpedo mine defences were adjusted and moored for use against ships, the submarines would pass under them and drive home an attack on the ships inside. When the ships were disposed of by driving them away or sending them to the bottom, the boats would practise against the shore works within range of the bow pneumatic guns, covering themselves under water between shots, as in the case of operations against mines and obstructions protected by shore batteries.

In a diversion against a strong place it might be good tactics for the boats to run in past all defences and drop a few aerial torpedoes into the town itself, or into a dry-dock upon which the enemy depended.

As has been shown, torpedo mine fields and floating obstructions could be cleared away or under-run; torpedo boats could not stop submarines; dirigible torpedoes would have no target to be directed upon, and, besides, could be avoided

by rising above or dropping below the plane in which the torpedoes run. Torpedo batteries could well be chanced, though these would be very dangerous to submarines if a number of torpedoes were fired at once—set to run at depths varying from two fathoms to the greatest depth of water in front of the battery—and if the running past by the submarines were attempted in the daytime, when their motions might be made out from commanding look-outs.

Well-placed and bulky sunken obstructions, which would seal the port to friend and foe alike, would of course prevent the entrance of submarines.

Conclusions.

From all the above it will appear that submarine boats owe their capability for usefulness to the fact that they can take cover in water as shore forces can in earth; that when so covered they have under certain conditions an offensive power that cannot be neglected; that until their exact powers are gauged by experience they would accomplish much by affecting the *morale* of the enemy; that although they have a wide field of usefulness, they do not fill the places of battleships, cruisers, or fast torpedo vessels; and that they are especially needful to a country weak in numbers of armoured ships when opposed by a strong naval power.

This is true of submarine boats of offensive, defensive, and manœuvring powers that can be built to-day; but if their development in power parallels that of other fighting machines, their field of usefulness will greatly widen.

X——.

DEFENCE AGAINST THE SUBMARINES.

Some months ago the papers were filled with reports of the successful experiments conducted at Portsmouth on the destroyer 'Starfish.' These experiments were for the purpose of showing how easily a submarine might be blown up; a

barrel moored in the path of the destroyer was successfully elevated sky-high, but there still seems some doubt about the submarine. No very great skill is required to pulverize a conveniently anchored barrel,—but a submarine, moving ten knots, and appearing for 30 seconds, will put a different light on the subject. The following description of the apparatus employed is from the 'Engineer':—

'On the starboard side the plates of the destroyer had been much strengthened. Above these is a crutch, upon which a boom, 42-ft. long, works. This boom normally stows inboard and forward. At the far end of it a charge of explosives is carried, explodable as are all spar torpedoes.

'On going into action the boom is slung out well forward, and immersed in the water at the proper moment. This immersion carries the boom end downward and aft, and it is exploded directly the submarine is passed. The speed of the destroyer carries her past the centre of the explosion before its full effects reach her, though in any case destroyers are too light and 'cork-like' to be seriously affected. The submarine down in the water is in a different case. It experiences the full force of the terrific concussion. Within from 60-ft. to 100-ft. or more of the centre of explosion, according to the charge employed, the sides of the submarine should be compressed sufficiently to cause fatal leaks, while even at a greater distance stability should be destroyed. It will be seen then, that the equivalent to a 'miss' is hardly to be expected.'

Scarcely pleasant for the submarine. However, this is solely a little encouragement to the down-hearted, and the officers who conducted the experiment would be the last in the world to believe in its efficacy against modern submarines. It would prove about as useful as the method proposed some time since, of firing high-explosive shells, fitted with time fuses on every square yard of water, as then one would be sure to hit a submarine if there happened to be one. A far more likely plan would be to run torpedoes fitted with time fuses in the direction in which a submarine boat had been seen.

The worst of all these plans is that they presuppose the submarine boat to have been seen,—a by no means permissible supposition. As, however, torpedo craft may prove of

CCLXII. THE ILL-FATED DESTROYER 'VIPER' STEAMING 37·113 KTS. Photo by Parsons Marine Steam Turbine Co.

utility in defence against submarines, I propose to give a short summary of the various types possessed by the chief Naval Powers.

England.

Of destroyers England possesses 133. They have the following speeds:— Destroyers

25.5-26.9 knts.	27-27.9 knts.	28-29.9 knts.	30 knts. and over.
21	34	6	72

Of the thirty knotters the following have made or are to make 31 knots or over:—

'Taku'[1]	35·2 knots.	'Eden'	35 knots.
'Velox'	34·8 ,,	'Albatross'	31·5 ,,
'Express'	33 ,,	'Wolf'	31·2 ,,
'Arab'	32 ,,	'Star'	31 ,,

1 Taken from the Chinese.

The 'Cobra' which lately collapsed on the Outer Dowsett Bank off Grimsby, accomplished 36.9 knots with 12,000 I.H.P. The 'Viper,' wrecked during the manœuvres of 1901, made 37.113 knots in Stokes Bay with 10,500 I.H.P. These two vessels were the only two turbine destroyers in existence, and were besides the swiftest ships in the world.

The dimensions of British destroyers range from:—

Length	180 ft.[1] to 235 ft.[2]
Beam	18·5 ft.[3] to 21·7 ft.[4]
Draught	5 ft.[5] to 8 ft.[6]
Displacement	240[7] to 430 tons.[8]
I.H.P.	3,000[9] to 9,250[10] = 26·08 to 33 knots.
Complement	44[11] to 68[12]
Coal Capacity	30[13] to 100 tons.[14]

1 'Hornet' and 'Havock.' 2 'Express.'
3 The first batch of 27 knots ordered; 'Charger,' 'Hasty,' and sisters.
4 Most of the 30 knotters. 5 'Taku.'
6 The last ten 30 knotters of the 'Orwell' type; the 'Viper' drew 8.2 feet.
7 Same as 1. 8 Same as 2. 9 'Havock.' 10 'Express.'
11 'Hornet' and 'Havock.' 12 'Albatross.' 13 'Charger.'
14 'Albatross' 'Express' will probably carry a few tons more. 'Cobra' carried 107 tons.

Nineteen destroyers of a heavier type are at present under construction; their dimensions are as follows:—

Length	225 ft.
Beam	23.5 ft.
Draught	8.5 ft.
Displacement	550 tons
I.H.P.	750
Speed	25.5 knots

The 'Eden,' one of these, is being fitted with Parsons' turbines; the 'Velox' the other turbine destroyer, is remarkable in that both turbine and reciprocating engines are fitted, the latter for employment for all speeds up to 12 knots and for going astern, the former for high-steaming. She is said to be the strongest destroyer afloat.

Torpedo Boats

Of torpedo boats we possess 177, and of these 110 are first-class. Since 1893 we have practically renounced the construction of these small vessels in favour of destroyers, but some slight start was made again two years ago by the order of four of 25 knots from Messrs. Thorneycroft.

The speed of these vessels is as follows:—

Under 20 knts.	20-21.9 knts.	22-23.9 knts.	24 knts. and over.
95	49	20	13

The dimensions, following the system adopted with the destroyers, are:—

Length	87 ft.[1] to 166 ft.[2]
Beam	10 ft.[3] to 17·5 ft.[4]
Draught	3·7 ft.[5] to 8·5 ft.[2]
Displacement	28[1] to 194 tons.[2]
I.H.P.	360[3] to 2,900[2] = 16·9 to 25·3 knots.
Complement	15[6] to 32.[2]
Coal Capacity	7[7] to 35 tons.[4]

The second-class boats, of which there are 67, have speeds of from 14.5 knots[8] to 17 knots,[9] and are mostly relegated to harbour work and boom defence.

1 20 knotters. 2 Nos. 109-113 3 No. 20. 4 No. 81 ex 'Swift.'
5 No. 90. 6 Nos. 3-79. 7 Nos. 1-20. 8 Nos. 1-9. 9 Nos. 49-50.

France.

Destroyers

France has only recently commenced building destroyers, and possesses comparatively few of them. She has 32 completed and 8 projected. Of those finished, one the 'Takou' had a trial speed of over 32 knots, 11 make 28 knots and the rest are 26 to 27 knot boats. The 'Takou' is one of four taken from the Chinese, and divided amongst England, France, Russia, and Germany. They were built in Germany by Schichau, at Elbing, in 1898, and all are said to have attained over 35 knots on trial.

Torpilleurs de Haute Mer

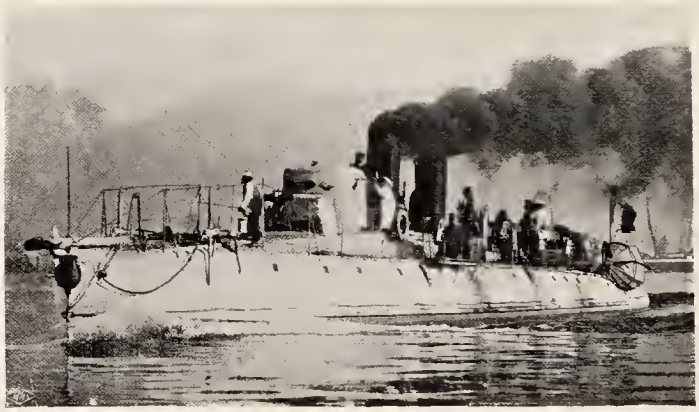
What France lacks in destroyers she amply makes up for with her sea-going torpedo-boats, the famous 'Torpilleurs de Haute Mer.' Of these she possesses 43; six[1] of them are armoured over the engines and boilers, with one inch vertical N.S. armour, and a partial protective deck .4-in. thick on the flat, and one inch on the slopes. Their dimensions vary as follows:—

Length	137·9 ft.[2] to 165·5 ft.[3]
Beam	14·5 ft.[4] to 15·9 ft.[3]
Draught	6·9 ft.[5] to 9·3 ft.[6]
Displacement	104[7] to 200 tons.[3]
I.H.P.	1,000[8] to 4,200[9] = 20 to 31·2 knots.
Complement	25[10] to 34.[11]
Coal Capacity	14[12] to 40 tons.[13]

The speed of some of these vessels is remarkable, the 'Forban' having created a record for craft of this type with a trial run at 31.2 knots per hour, with 4,000 I.H.P. Eleven

1 The 'Sirocco,' 'Mistral,' 'Trombe,' 'Audacieux,' 'Simoun,' 'Typhon.'
2 'Aquilon' and 'Cerbère.'
3 'Lansquenet.'
4 'Forban.'
5 'Chevalier.'
6 'Argonaut,' 'Tourmente,' 'Averne,' 'Dauphin.'
7 'Agile.'
8 'Filibustier.'
9 The 'Cyclone' and ten sisters.
10 'Tourmente.'
11 'Mangini.'
12 'Sarrazin' and 'Tourbillon.'
13 'Alarme' and her five sisters.

others, the 'Cyclone,' 'Sirocco,' 'Mistral,' 'Simoun,' 'Typhon,' 'Trombe,' 'Audacieux,' 'Bourrasque,' 'Rafale,' 'Borée,' 'Tramontée,' have speeds of between 30 and 30.5 knots, whilst in sea-going capabilities they are the equal of our much larger destroyers, accompanying the various fleet all through the annual manœuvres. The armament consists of two to four tubes, and a couple to four three pr. Q.F. Twenty-two in all have speeds of over 25 knots, the others varying from 20.5 in the earlier vessels to 24.7 knots in the 'Mousquetaire,' built in 1893.



By favour of the 'Navy and Army Illustrated'

CCLXIII. A FRENCH TORPEDO-BOAT

1st Class T. Boats

Besides these destroyers and 'Torpilleurs de Haute Mer' France possesses 148 first-class torpedo boats finished or building, with another 140 projected. Of these, eight are old boats, built in 1886—1888, and having speeds of 20 knots and under. The rest are all fairly modern, and steam from 21/25 knots, whilst numbers 212—216 made considerably over 26 knots on trial. No. 243, at present on the stocks, is to be fitted with turbines, and will have six screws. The armament of the French first-class boats consists of two torpedo tubes and two small quick-firers. By the estimates of 1900, 115 new 86 ton vessels are to be added by 1905, and 46 more by 1907. Of these 161 proposed, 21 have been included in the total already mentioned, so by 1905, 140 new vessels will have been added.

2nd Class T. Boats

The second-class torpedo boats are 76 in number. Their speed varies between 19 and 21 knots, and their displacement

from 45 to 55 tons. Several of them are as much as 23 years old, whilst the majority date back to 1885-90.

3rd Class T. Boats

Of third-class torpedo boats France has 51. One of these, the 'Libellule' is fitted with turbines, and a speed of 35 knots is anticipated. With the exception of 12 others, the rest of this class are obsolete, and must shortly be relegated to the scrap heap. Their speed is between 16 and 18 knots.

Russia.

Destroyers

Turning to Russia, we find this country already the possessor of 44 destroyers, although she did not start building them till 1898. Strangely enough the oldest, in fact the only one built prior to 1898, is also the fastest.[1] This vessel, the 'Sokol' attained 30.28 knots on trial. The following are the dimensions of these vessels:—

Length	190 ft.[1] to 210 ft.[2]
Beam	18·6 ft.[1] to 23 ft.[3]
Draught	7 ft.[1] to 12·9 ft.[4]
Displacement	240[1] to 370 tons.[4]
I.H.P.	3,800[5] to 6,000[4] = 26 to 30·28 knots.
Complement	55.
Coal Capacity	53[6] to 80 tons in the new boats.

1st Class T. Boats

Of first-class torpedo boats, Russia has 104 built or projected. These vessels have speeds from 18.5 to 25.5 knots, the fastest being the 'Adler,' which reached 27.4 knots on trial, with 2,200 I.H.P. These little vessels are divided between the Black Sea and Siberia, 29 going to the former, and 11 to the latter place; the remainder are stationed in the Baltic.

2nd Class T. Boats

The second-class boats are 112 in number, and of these 13 are in the Black Sea; here also are 50 boats of the 'Woron' class, built many years ago, and having a speed of 17 knots. Another 21 of the same type are in the Baltic.

1 Excepting the 'Taku' taken from the Chinese.
1 'Sokol' and earlier boats.
2 Latest vessels.
3 'Kit' and three sisters.
4 'Som.'
5 (2) All except 'Sokol.'
6 'Gagara' and three sister ships.

None of these vessels are of any great importance, the speed of the best being only 17.5 knots.

GERMANY.

Destroyers

Germany is not fond of the term 'destroyer,' so she calls them Division Boats, of which she possesses 34. Besides

By favour of the 'Navy and Army Illustrated'

CCLXIV. A GERMAN TORPEDO-BOAT

these there is the 'Taku' of 35 knots. The division boats have the following dimensions:—

Length	185·4 ft.[1] to 223 ft.[2]
Beam	19·6 ft.[3] to 24·4 ft.[4]
Draught	7·6 ft.[3] to 10·7 ft.[5]
Displacement	250[1] to 380 tons.[4]
I.H.P.	1,800[1] to 5,500[3] = 21 to 27·5 knots.
Complement	48[6] to 59.[7]
Coal Capacity	40[7] to 90 tons.[8]

Most of these were built at Elbing, but one, D 10, is a 'Thorneycroft' boat, and besides being the most powerful,

1 D 1-2. 2 D 90-113. 3 D 10. 4 D 9. 5 D 5-6. 6 D 1-6. 7 D 11-12. 8 D 3-6.

this vessel is the fastest. These division boats are very sea-worthy, and look very formidable, as anyone who saw them at Portsmouth, at the funeral of her late Majesty, will know.

1st Class T. Boats

Of these vessels Germany has 112; they are comparatively large boats, displacing from 80 tons in the older types to 160 tons in the most recent. These latter boats, of which there are seven, have a speed of 26 knots, with 2,300-2,500 I.H.P. The speed of the remainder varies between 19-25 knots.

2nd Class T. Boats

There are only five second-class torpedo boats, and to these may be added 16 vedette boats of 15 to 18 knots. Altogether Germany has a most powerful and well organised torpedo flotilla.

Italy.

Destroyers

Italy owns 13 destroyers, all of which are afloat, 16 more are contemplated, and will probably have been commenced before this appears in print. They are, with the exception of the 'Fulmine,' of two distinct types, and have the following dimensions:—

	I.	II.	'Fulmine.'
Length	200 ft.	210 ft.	200 ft.
Beam	21·6 ft.	19·6 ft.	20·4 ft.
Draught	8·8 ft.	7·6 ft.	?
Displacement	320 tons	350 tons	298 tons.
I.H.P.	6,000	6,000	4,800.
Speed	30 knots	30 knots	28 knots.
Complement	53	53	43
Coal Capacity	80 tons	80 tons	60 tons.
Torpedo Tubes	2	2	3

The 320 tons vessels are replicas of the four taken from the Chinese, by the Allies, having been built by the same firm. The 'Fulmine,' the pioneer of the Italian destroyer flotilla, is somewhat smaller than the rest.

1st Class T. Boats

The eleven first-class torpedo boats possessed by this country are fine speedy sea-worthy vessels. Five of them, known as the 'Aquila' class, accomplished well over 26 knots on trial, with 2,200 I.H.P. The largest of these eleven vessels, the 'Pelicano' displaces 150 tons, and has an I.H.P. of 2,700,

with which on trial 25.2 knots was logged. The 'Condore,' a boat of 136 tons, made 26.5, with 2,400 I.H.P.

2nd Class T. Boats

The second-class torpedo boats are 90 in number, and are of three different types:—

	I. (30)	II. (40)	III. (20)
Dimensions	127·7 × 15·6 × 6 8 for all 3 types.		
I.H.P.	1,000 = 22·5 kts.	1,200 = 23 kts.	1,000 = 22 kts.
Displacement	85 tons for all.		
Torpedo Tubes	3	2	2
Coal Capacity	17 tons for all.		

3rd Class T. Boats

There are likewise 39 third-class torpedo boats, with speeds varying from 18 to 22 knots, and 20 officially designated fourth-class boats. These last however, have owing to their lack of speed (about 12-16 knots) been cut off the effective list, and are used for Police duties on the Lakes.

U.S. America.

Destroyers

America, following out the excellent system of going or endeavouring to go one better than her neighbours, has created the most powerful destroyers in the world. Of these she has 20, and the following are the dimensions of the four chief types:—

	I.	II.	III.	IV.	'Farragut'
Length	242 ft.	244 ft.	245 ft.	248 ft.	210 ft.
Beam	22 ft.	24 ft.	23 ft.	23 ft.	20 ft.
Draught	6 ft.	6 ft.	6½ ft.	6 ft.	6 ft.
Displacement	400 tons	408 tons	420 tons	433 tons	273 tons.
I.H.P.	8,400	7,200	8,000	8,300	5,600
Speed	30 kts.	29 kts.	28-29 kts.	30 kts.	31·76 on trial.
Complement	64	64	64	64	?
Fuel	123 tons	150 tons	139 tons	202 tons	95 tons.
Torpedo Tubes	2	2	2	2	2

The 'Farragut' is included as being the first of the American destroyers. These vessels have not met universal favour in the land of the Stars and Stripes, and it is rumoured that no more are to be built.

Photo by the Builders

CCLXV. THE JAPANESE DESTROYER 'ASASHIO;' BUILT AT CHISWICK, BY MESSRS. THORNYCROFT

1st Class T. Boats

The 28 first-class torpedo boats, are, like the destroyers, of larger size than is usual with the vessels of their class in other countries. The displacement ranges from 142 tons to 182 tons, and the speed from the 22.5 knots of the 'Cushing' and 'Davis' to the excellent 30.5 knots of the 'T. A. M. Craven.'

2nd Class T. Boats

The rest of the flotilla is composed of five second-class boats, with speeds from 18.2 to 21.15 knots, and the 'Barcelo' and a few others of less importance captured from Spain during the war of 1898.

I will now summarise the detailed accounts just concluded, and will add the torpedo craft possessed by several of the smaller Powers to those already enumerated.[1]

Nation.	Destroyers.	1st Class T.B.	2nd, 3rd & 4th Class T. B.	Total.
England	133	110	67	310
France	40	288	121	449
Russia	44	104	112	260
Germany	35	112	21	168
Italy	29	11	149	189
U.S.A.	20	28	5 (?)	53 (?)
Japan[2]	20	55	66	141
Austria-Hungary	—	30	38	68
Greece	4	12	35	51
Holland	—	20	28	48
Sweden	1	16	18	35
Spain	4	19	6	29
Turkey	4	26	—	30
Denmark	—	14	11	25
Norway	—	16	4	20

Besides these, the Argentine, and other small States possess a few destroyers or torpedo boats, but they need scarcely enter into the discussion of the Naval strength of Europe.

I have already expressed my opinion as to the value of torpedo craft as an antidote for submarines, but nevertheless give the above list of the Mosquito fleets of the world (cribbed

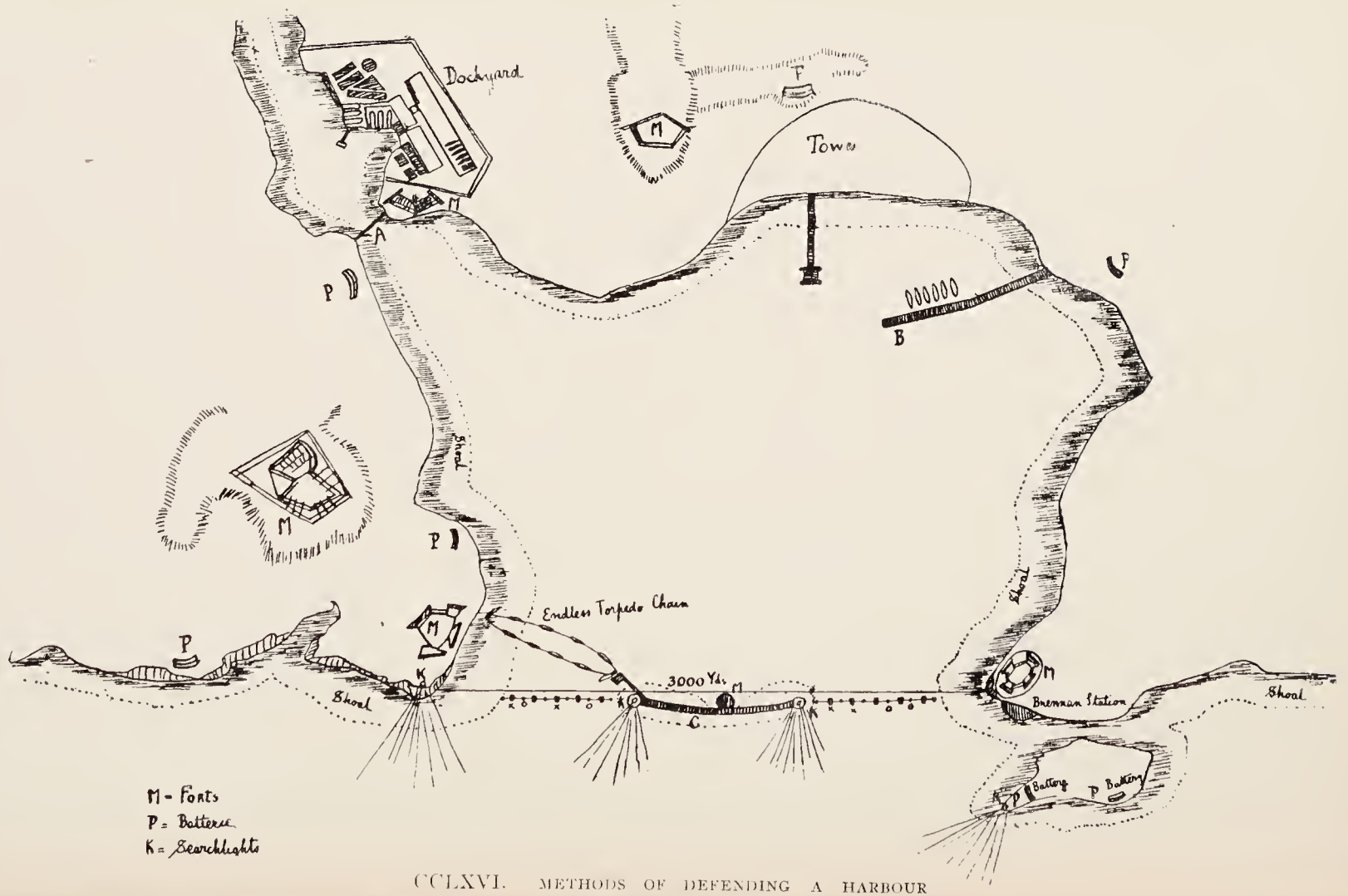
1 This summary includes all building or projected.

2 Including the ten years' programme.

for the most part from half a dozen Naval Annuals) for what it is worth.

The only real antidote to the submarine would be the Air ship, but that, alas, in spite of the success of that enthusiastic and most persistent of balloonists, M. Santos Dumont, seems still far enough away. It has been proved however, that a submarine is easily discernible from a balloon, even if submerged to considerable depths. A combination of the 'Actinaut,' and a towing balloon such as employed in the German Army, might conceivably be a way out of the difficulty. Such a balloon, fitted with wireless controllable torpedo apparatus, attached to a battleship or cruiser, could, on sighting a submarine boat, signal to its escort to release an 'Actinaut,' and from its elevated position guide this weapon over the submerged vessel. On detonation very little of the submarine boat would remain, even if submerged 25 feet—deeper than which it could not be seen from above.

Another method applicable to harbour warfare, would be for a number of picket boats, on the alarm of a submarine to surround a harbour, and slowly converge into the centre, keeping the small quick-firer specially mounted in the bows, directed well in front of them. In such harbours as Plymouth, Portsmouth, or Dover, the shoals would necessitate a constant reference to shore bearings, and on appearing at the surface the concentrated fire of all the picked boats, probably 20 or 30, would be directed upon it. There would be very little doubt but that one or two of the shot would find a billet. This brings us to the protection of harbours; even if the idea as explained above is feasible, prevention is always better than cure. Portsmouth has a well-organised boom defence, a boom being swung across the harbour from the Block House Fort to the East Battery, where the connecting chains may often be seen at low water. From this boom, chains and net-work could be suspended, and woe betide any submarine that became enmeshed in such an obstruction. The same kind of defence might be fitted from Devil's Point to Mt. Edgecumbe Battery, at Devonport, though the removal of the buoys marking the Drake Canal would be all sufficient. Anyone who has noticed the strength of current rushing round Drake's Island, will know that for a submarine boat to venture there, even with



CCLXVI. METHODS OF DEFENDING A HARBOUR

the course marked out, would be the height of foolhardiness. Observation and contact mines are also likely to play a good part in the defence of harbours against submarines, judiciously placed with outlying buoys, this method may possibly be the most efficacious of the lot. The appended diagram shows the manner in which such mining could be worked. A, is a boom defence defending the dockyard, B, a jetty for the protection of torpedo craft, C a breakwater. The distance between the two points M N is 3,000 yards. Of this, 1,000 yards is protected by the breakwater, and another 800 yards is shoal—400 yards on each side. This leaves 600 yards on each side to be protected. Now the effect of a mine on a battleship is practically nil at 20 yards, perhaps a slight shaking up and a temporary dislocation of some minor engine. But to a submarine submerged the effect of a mine (about three times that of a torpedo) would be sufficient to place it *hors de combat* at 60 yards to a certainty, and perhaps even further. Mines X X X would therefore be placed at every 120 yards across the Channel, these mines would be connected to one another by a rope net, supported midway by buoys 0,0, and so attached that any object moving the rope or buoys between any two mines, would explode those mines. Hence there would be a mine exploding on either side of a submarine in the event of any attempt to enter the harbour. The result of this double explosion would certainly be the disablement of the submarine. By day, should a friendly vessel desire to pass, the electric current would be cut off, and one of the buoys disconnected, when shore pilots could bring in or take out the vessel according to requirements.

Another method proposed is to have an endless wire working on pulleys near the shore, and supporting a line of torpedoes, say one every two hundred yards. There would then be two lines of continually circulating death, through which a hostile vessel would have to pass. By an arrangement of the pulleys these lines could be made a quarter of a mile apart. This, besides being a good sound means of defence, is an idea for the utilization of obsolete torpedoes, of which the British Navy has over 2,000. Any type or condition of weapon would do so long as it was capable of floating and holding a good heavy charge. The motion would be obtained from the shore,

and the engines of torpedoes so employed might be replaced by their weight in guncotton, or other explosive. It requires the stern test of war, however, to bring out the inventive genius of a nation, and no doubt many scores of means for defence against the submarine, will have been evolved before a war has been in progress a week. But after all, the best defence against such vessels is to have them ourselves. If our enemies sink our battleships with submarines, we will destroy their big craft with submersibles, and it then becomes a matter of which can make its fleet last longest; considering the number of vessels we possess we should have more than an even chance of coming in first. The battle fleets destroyed, the submarine is utterly incapable of carrying on a war by itself, and the country that still held the command of the surface of the sea, would be the victor.

Nothing, however, can be decided without the severe trial of battle, and the prolonged continuance of peace militates against so dreadful and unhoped for an eventuality ever occurring. Perhaps the submarine is destined never to be used in anger—who can tell?

THE VALUE OF SUBMARINE BOATS.

By Admiral Sir John Hopkins, G.C.B.

The problem of appraising the future value of submarine boats as a fighting factor at sea presents many difficulties, but if we confine our criticisms to their undoubted utility as coast or harbour defenders, we stand on surer ground.

For it is hardly to be denied that within the narrow limits of their 'sphere of action' the possession of these invisible and mobile craft, from which the dreaded torpedo can be discharged, with perfect immunity from an opponent's projectiles, constitutes another potent force to be reckoned with when in the vicinity of an enemy's port. And consequently a blockading force or a look-out vessel has one more new

danger to guard against, none the less formidable because its merits are for the moment somewhat obscure.

And if it is presumed that no well defended harbour will in the future be subjected to bombardment by fleets or ships, the assumption receives additional force when the submarine boat has to be reckoned with, as the strength of this arm lies for the present in its undoubted utility, when acting from a near and well-known base, though its power to act at a considerable distance from its base or its aggressive value when towed about with a sea-going squadron, ready to take its part in a sea engagement, is more problematical.

But of this we may be certain that the 'submarine' is an improving weapon, that its development is as sure as is the progress of all inventions that have a fighting value, and that to ignore its power because underwater fighting is not to our taste, would be simply ridiculous.

Hence the wisdom of the Admiralty in having some submarine boats constructed, though I doubt the expediency of having the whole five of one type or pattern, when several kinds would give us the advantage of comparing values and appropriating the best points of each sort.

My view, therefore, of the submarine boat is, that it has come to stay, that its value in the future as a defensive weapon against harbour attacks or a blockading force is undeniable, that its development is a certainty, and that when for defensive purposes it is pronounced efficient, the genius which created it will soar towards the higher ambition of making it equally effective for offensive work in blue water, with every probability of succeeding. And if we take a serious view of the future power of the submarine boat, does it not lead us to contemplate anew with some anxiety the growing size and cost of our ships whose destruction by a single 'Whitehead' is a catastrophe to be reckoned with, the more especially as this weapon may now be brought upon the scene of action 'as a thief in the night.'

And since the torpedo has (with its gyroscopic fitting) become a most reliable 'runner' with a range of 1,000 yards, at a 30 knot speed, does it not point to the advisability of smaller and less costly, but more numerous, ships to meet this new development.

And who shall say where this development is to stop, for if in the future the 'submarine' can be carried at sea, as is at present the second-class torpedo boat, then practically every large ship will have this weapon in her armoury ready to launch into the fray at the opportune moment.

THE VALUE OF THE SUBMARINE.

FRED. T. JANE.

The whole question of submarines seems misunderstood by the inventors of them. The main problem is to find the enemy: all other points are subsidiary details. To be superior to any existing type of above-water vessel a submarine must have the same ability to detect the enemy and the same speed to reach her. Therefore, it would seem that she must have the same size more or less. Failing this, she is merely a compromise that sacrifices vision and speed for the sake of a protection that may be wholly unnecessary in view of what is paid for it. At present submarines appear to be chiefly a species of bogie so far as practical work is concerned, and the only sure ground is the fact that the few who are in a position to form an estimate as to the *war* value of a boat would not be in that position but for the certainty that they will not tell what they know.

The claims of inventors and of others connected with the construction of submarines appear to me to be of small value; at any rate a deduction of fifty per cent. will do no harm. Several submarine 'failures' seem to have been quite as efficient as several successes. I may be wrong, but the inference I draw is that 'success' and booming the boat may be closely connected.

This applies to the submarine proper in its present stage, and also with equal weight to the submersible. Though this type, by reason of superior speed, is better able to find an enemy, the time it will then lose in submerging seems like a

throwing away of chances. It is quite possible that the boat would elect to attack as an above-water craft: it then becomes an above-water boat, hampered by loss of speed and an ordinary armoured boat would be non-effective.

I refuse absolutely to believe in the contention of the inventors that a submarine is safe from attack. Such a claim is rubbish. If no antidote yet exists, it is certain to be found. The history of war proves that. Even Greek fire—the most deadly (relatively speaking) war agent ever employed was neutralised and combated in the past: modern science is certainly not going to throw up its hands to the submarine.

Partly in view of this, and partly because I anticipate a growth of torpedo range till above-water craft can fire them as far as guns will carry, I cannot believe that either submarine or submersible will go further than the dynamite gun—at any rate in their present form: and if ever they do it will have to be with some special weapon of their own, not with weapons borrowed from above-water craft.

For coast defence they should have uses: but it should be remembered that without them coasts and harbours are very tolerably secure. I do not see that they will affect the blockade much, for the above-water boat appears to have done already all that it is claimed that submarines will do.

Finally, I have no evidence that a single submarine has yet done anything under *war* conditions. This being so it still remains in the experimental condition.

SUBMARINE BOATS.

By Rear-Admiral S. Eardley-Wilmot.

In the summer of 1886 I happened to be at the Piraeus, in command of a ship, when the first 'Nordenfelt' submarine boat was there, under process of being handed over to the Greeks, who had purchased it. Any detailed description of this craft would be outside the scope of these remarks. She was propelled by steam, both when above and when below the sur-

face, the latter process being effected by lowering the funnel, shutting off the fires and utilising the remaining steam in the boiler, supplemented by steam from a reservoir or cistern of boiling water, provided for that special purpose. When submerged, she had, I presume, the defects of all such craft, as want of longitudinal stability, and inability to see where you are going. The heat inside must also have been very great. When, however, I saw her steaming about the harbour with only a small conning tower—large enough for a man's head —visible, and noted how difficult it would be to detect her approach, I came to the conclusion that the great advantage of a submarine boat was to go on the surface. That opinion I have held ever since, and now observe the tendency in France to be towards a boat that can be totally submerged when required, but that surface navigation is considered more important. I believe that for the special purposes of torpedo attack, or reconnoitring, the future boat will be one which, while retaining the advantages of the ordinary torpedo craft, can at short notice be immersed sufficiently to become almost invisible without losing entirely the power of seeing the object. Why do we find other nations devoting so much money and attention to these submarines? It is mainly because they see in them a means of more effectually using the locomotive torpedo. This weapon is directed against the most vulnerable part of the ship, for which so far no efficient protection as regards construction of the hull has been devised. We clothe a ship with three or four thousand tons of costly armour to guard her against shot and shell, but under water the bare hull is exposed to attack; a double bottom of thin plating is no protection against the explosion of 100 pounds of high explosive carried in the 'Whitehead' torpedo.

On the other hand the low velocity of this subaqueous projectile as compared with the gun, and the consequent liability to inaccuracy on its course, render close range with the torpedo necessary. When we say that the torpedo boat must approach within 600, or at the most 800 yards of the object before she can discharge her missile, we realize how important an attribute invisibility is in such a craft in view of the great number of small guns that would play upon her, aided at night by the powerful search lights with which ships are now sup-

plied. The ordinary torpedo boat soon betrays her presence by sparks from the funnel and escaping steam, as under the rays of the search light white shows more conspicuously than any other colour. She may slow down and stop the sparking, but the steam will then probably escape in greater volume. When discovered, her only alternative to retreat is to go full speed for her object. In the case of a boat capable of being immersed at any time, and at short notice, until only a small portion remains above the surface, emitting no sparks and exhausting her steam, if she is propelled by it, under water, she in day-time would be most difficult to locate, and at night-time should quite baffle discovery. Waves might dash over her, but the boat being tightly battened down fore and aft no water could penetrate below; and on getting within the prescribed distance she discharges her torpedoes. Even suppose she is detected, how difficult to hit such a small object compared with the ordinary boat, the greater portion of whose hull is above the surface. Consider also the advance which torpedo boats have made in size from a length of 90 feet to 150 feet, affording a good target for the quick-firing guns, manipulated from the shoulder and having great inherent accuracy. We see periodically exercises at the sea ports when torpedo boats attempt to run past forts having such guns and many search lights. The report usually is 'all the boats were speedily discovered and put out of action.' The result is decided on the boat being discovered and kept under the rays of the light within range for a certain time. Here everything is in favour of the guns, the night is fixed, the hours limited, during which the attack can be made, and the look-out kept is keen and unwearied. How more difficult for the defence if immersible boats were employed, and they crept in when the vigilance of the watch had relaxed. Speed has to be sacrificed to obtain invisibility, but even so I think such a craft will prove more formidable to a blockading force than the boat which trusts to speed only to accomplish its mission. My opinion of submarine boats therefore is, that the power of navigating under water is of little value, but that the partially immersed vessel conduces to the more effective use of the locomotive torpedo, as well as reconnoitring. It will not revolutionise naval warfare, for we must employ the same

principles to bring this to a successful issue as we found effective after centuries of experience; but we must ascertain by experimenting with the same weapon its capabilities and the best way of meeting it.

We finally come to the question, will the submarine boat as making torpedo attack less difficult affect the construction of warships. I think not until war demonstrates that this weapon has the power claimed for it. We continued to build wooden ships long after shells were introduced; but it required the experience of the Russian War to produce ironclads. In the same way now, as far as the construction of the ship is concerned we practically ignore the torpedo. Apparently we either hold the torpedo in contempt, or consider no constructive additions would avail. The nets supplied to keep out torpedoes are too crude to merit description. They cannot also be used at sea, where we trust to guns and destroyers to ward off this attack. I believe, however, it is not impossible to provide as good a protection against the torpedo in constructing the hull of a war ship as we now do against the gun. It must be an important feature of the preliminary design, and may take the form of a third skin considerably outside the others. It may be a revolution in naval architecture as great as that which differentiates the 'Warrior' from the 'Victory,' and the 'Majestic' from either; but the torpedo is slowly forcing its way into recognition, and like steam will eventually have its day of triumph.

On October 28th I received the following letter from Rear-Admiral Bettolo, of the Royal Italian Navy, and, as he suggests, I append his opinion on the subject as expressed in Mr. Jane's wonderful Naval Annual.

Valencia,
24/10/1901.

'Dear Sir,

'I received your letter at Valencia in Spain, where it reached me on my return from a sea-trip.

'I beg to thank you for your kind invitation to co-operate

with you in the work you are undertaking, with regard to which I may point out, referring you to Mr. Fred T. Jane, of Portsmouth, that I have already had occasion to express my ideas on submarine war-vessels, and my views in the matter, in a work brought out under the supervision of Mr. Jane, and published under the title of 'All the World's Fighting Ships' (fourth year).

'There would be nothing to demonstrate in the matter, and moreover the subject could not be treated without referring to subsequent developments; this I do not think opportune.

'In the meantime, however, if you think it of use to collect and arrange these ideas of mine, and publish them in your forthcoming work, I shall be both pleased and flattered.

'Yours etc.,

(Signature) G. BETTOLO,
C. Ammiraglio.'

Extract from p. 340, 'All the World's Fighting Ships, 1901,' by Fred. T. Jane.

'Studying the progress in the construction of submarine boats, the difficulties overcome, the nature of those yet to be overcome in order to confer on them the qualities required by a wider and securer use in war, it seems to me, that one may conclude that the action of the new instrument must, in naval war, remain limited by particular conditions of time and place; that is, in the field of a strict defensive, limited to the waters of gulfs, ports and passages of military importance.

'Otherwise one would require to argue—if it were permitted to hope—for a solution capable of transforming the submarine boat into a submersible torpedo-boat, fit to perform long routes at sea, like the ordinary torpedo-boats, even with a relatively moderate speed and capable of being submerged, to be rendered invisible, until the tactical contact with the enemy is reached.

'It does not seem, however, that such a hope can have foundation. To that solution are opposed, in my opinion, insurmountable difficulties inherent in the very nature of sub-

marine boats; difficulties which do not permit of conferring on these boats, even when they sail on the surface, conditions of habitability and navigability at all sufficient.

'I think that the enthusiasm with which in some countries, the studies and the building of submarine boats have been accompanied is in great part due to the feeling implanted in human nature, by which danger appears the greater in proportion as it is more mysteriously and insidiously able to threaten the existence of its adversaries.'

SUBMARINE BOATS.[1]

LIEUTENANT A. TREVOR DAWSON.

Submarine boats bear on the subject of Naval Ordnance—not so much in association with gunnery, but with torpedo armaments, which constitute a most serious factor in connection with our future naval history. Up to the present time the torpedo has been carried by most of our ships of war, but the maximum serviceability of the weapon must be obtained from such specially designed ships as the torpedo boat or torpedo destroyer. Now, however, a new field for the torpedo is opened out by the introduction of submarine or semi-submerged boats. Torpedoes are inoperative at a greater range than 2,000 yards, and must be discharged within closer distance, so that in the case of two vessels even otherwise unequal, but armed with torpedoes, the chances of success will be equal, and thus it would be impolitic under most circumstances for the superior vessel to take the risk of being torpedoed. For this and other reasons mechanical torpedoes should be utilised by specially constructed vessels, and particularly by boats capable of remaining unseen except for momentary re-appearances to take observation. This is a condition easily fulfilled by a submarine boat, much more

1 Reproduced by permission from Naval Ordnance, The Institution of Mechanical Engineers.

efficiently than by torpedo boats of the ordinary type. Attack by daylight would make them almost certain victims of any ship armed with a moderately heavy quick-firing gun, escape being impossible; whereas the submarine boat, if discovered, when porpoise-like she comes to the surface, can immediately dive, cruise under water for a few miles and make her escape to fight another day.

At the present time the French have thirty-four boats in various states of manufacture, twenty-nine of which are electric submarines, and five submersibles, and they are now carrying out important trials and spending large sums of money in their development. Before many years have passed France will have not thirty-four but hundreds, with which she would be able not only to protect her ports, but to make attacks on our fleet in much the same way as the bands of Boers made guerilla attacks on our regular army in the Transvaal. Of the continuous stream of ships passing up and down the English Channel—the busiest steamship track on the globe—quite 90 per cent. are British vessels, and upon them our mercantile greatness depends. Let us suppose that in time of war 100 French submarines were let loose in the Channel at night. These boats have sufficient speed and radius of action to place themselves in the trade routes before the darkness gives place to day, and they would be capable of doing almost incalculable destruction against unsuspecting and defenceless victims. The same applies to the Mediterranean and other of our ocean highways within the danger zone of the submarine.

The submarine boat has thus increased the value of the mechanical torpedo tenfold. To the United States of America the submarine will be of inestimable benefit, as it will render the coast practically secure against attack from any country, excepting those having naval bases within easy striking distance of their littoral. The boat now universally adopted by the United States is built on the 'Holland' system, and the new British boats building by Vickers, Sons, and Maxim, Limited, at Barrow-in-Furness, are of a similar design. They are to be almost equal in speed to the French boats, but have other qualities not attained by these boats, the principle of which is that they will be capable of behaving much in the same way as the porpoise. They are capable of coming up

and disappearing instantly, so that they can thus determine exactly the mark to be aimed at before discharging the torpedo. The quality of being able to dive in a few seconds renders them much less vulnerable to attack by artillery.

As to the periscope, of which the French speak so much, there is no doubt that when cruising submerged in the proximity of the enemy it will be very useful. It is an arrangement whereby a view of the surface through from 30 to 50 degrees can be obtained, and enables the boat when submerged to be steered directly for a visible point. The 'Holland' boat has a special arrangement for effecting this purpose, while enabling her to run at a distance below the surface, so that no visible trace of her can be seen. Such an arrangement places this country quite on a level with the French nation, notwithstanding the fact that we may not have given the same amount of attention to submarine warfare.

To some extent the Marconi system of telegraphy affects the range of utility of the submarine, as the operation of blockading no longer entails the use of so many vessels, because the distance through which a message can be signalled at sea has so much increased that one of our ships off the French coast may communicate direct with its base in Britain. It is true the speed of the submarine boat is not so great, but progress is certain. When the 'Whitehead' torpedo was first introduced it had a low speed, and generally speaking was very uncertain as to its direction, depth, and applied utility. Now, however, it is capable of running within a few inches of the required depth at a speed of over 37 miles an hour for a range up to 2,000 yards, and hitting the point aimed at with almost the same precision as a gun. In the same manner there is no doubt the submarine boat will be improved, while there is a great field for development in connection with the secondary battery. Here, indeed, as in many other respects, one finds that close interchange of interests between the mechanical engineer and the artillerist, which affords some justification for bringing before this Institution a subject of such great interest to the profession, fraught as it is also with such vital importance to every citizen.

SUBMARINE NAVIGATION

SUBMARINES: THEIR DISABILITIES.

MAJOR C. FIELD, R.M.L.I.

The submarine war-vessel has doubtless arrived—at any rate in France. Whether it has come to stay is another matter. Steam and electricity have supplied modern submarines with a means of moving either above or below water at moderate speed; the automobile torpedo provides them with a weapon which under favourable circumstances may deliver a deadly blow at any existing type of fighting ship. But setting aside these two points, that is to say their improved motive and offensive powers, in what way have even the latest submarine boats showed themselves very superior to that invented more than a hundred years ago by David Bushnell, which all but succeeded in blowing up a British man-of-war off New York? They are still blind below water, they are still of a speed which compares most unfavourably with that of any surface war-vessel. The periscope is all very well in theory, it may work excellently in a flat calm, but let there be the least ripple and its objective glass will be blurred and encrusted with salt. The French experiments have demonstrated that it is possible for a submarine to steer a direct course for a ship at anchor or moving at a very low speed, and after making several observations at the surface to strike her with a torpedo, but it must be remembered that on active service a ship's torpedo-netting would probably be down if at anchor, and other defensive arrangements would be either provided or improvised. It has yet to be shown that a submarine is capable of inflicting any damage on a ship moving at her ordinary rate of speed, especially if she should be continually altering course, as she most likely would be doing in the progress of a Naval engagement. As for harbour work it will probably be found on inquiry that nearly all experiments with submarines in port have been in wide open basins of known and uniform depth, a very much safer business for such craft than attempting to enter a port by winding channels, the least deviation from which would mean sticking in the mud and the suffocation of the crew. On the surface even buoys and leading marks are required to keep the navigator in the way that he should go, what chance

then has a submarine of steering a correct course? Add to this the many risks of fouling cables, moorings and submarine mines, and it will be seen that the submarine's chances of arriving within striking distance of her objective are extremely remote if she enters an enemy's harbour. A submarine being wholly surrounded by water, which presses on her in every direction, and having when below the surface little or no reserve of buoyancy, is singularly susceptible to the action of submarine explosions, much more so than are ordinary vessels. It follows therefore that a charge of high explosive detonated at a distance at which it would be innocuous to a ship on the surface might be fatal to a submarine. Once then let such a vessel be located by a destroyer provided with means for such under-water attack and her existence becomes a matter of minutes. Moreover it should not be hard to provide all ships with the means of rapidly sowing the sea where a submarine has been sighted with a shower of explosive charges, each capable of rendering such a vessel *hors de combat* at a considerable radius. In my opinion the submarine is at present infinitely more dangerous to herself and to her crew than to the enemy. It suits the French Government to 'boom' them if only because they appeal to the popular fancy, but those who remember the war of 1870, will recollect that the wonderful mysterious 'Mitrailleuses' were to have proved as formidable to the German Army as the submarines are supposed to be to the battleships of a possible enemy. The result in the first case was a dismal disappointment. It is not unlikely that the French 'Gymnôtes,' 'Narvals,' and 'Morses' would prove equally broken reeds to lean upon. The agitation for similar boats for our Navy, which some newspapers have tried to foster, is a most mistaken one, even if foreign submarines are all that is claimed for them. By all means experiment with a few as the Admiralty intend doing, but only in order to perfect means for their destruction. We cannot fight submarines with other submarines, as Mr. Goschen has aptly remarked, and our existing classes of war-vessels, manned with such men as form their crews, are quite capable of dealing with anything that floats.

SUBMARINE NAVIGATION

INTERVIEW WITH COLONEL VITTORIO CUNIBERTI,

(Chief Constructor to the Italian Navy.)

On Monday, October 21st, 1901, I had the pleasure of meeting Colonel Cuniberti, and he very kindly gave me a few of his opinions on the submarine boat, and its future value. He thinks that no country in the position of England requires such 'mechanical toys' as the 'Holland' boat. For France and other countries they might be useful. The policy of Great Britain should be to have a sea-going and not a coast-defence fleet, and for this reason we do not want submarines. What we required was large submersibles, and so sure was he of the correctness of this policy that he was endeavouring to obtain its adoption in Italy. The only fault of a submersible, said the Colonel is the necessity for a double means of propulsion. This had been obviated he thought, by the invention by himself of a special oil-motor which could work nearly as well beneath as on the surface. Then too for stowage of fuel oil was so much more handy, and when stowed it could be got at so much better. He thinks it possible that with the adoption of this engine and the new optical tube, the cléptoscope of Engineers Russo and Laurenti—which he assures me is a perfect apparatus, an efficient submersible torpedo boat should not be hard to construct. Although he would not go so far as to say the submarine had no future, he considered that vessels of the purely submarine type would be relegated to Coast Defence. Questioned as to the moral effect, Colonel Cuniberti considers this to be one of the strongest points in favour of the submersible, and if he were commanding a submersible he would make several dashes to the surface close to the enemy, until assured that he had been seen by them. This accomplished, he would quietly submerge, confident that the enemy, knowing of the presence of a submersible in the vicinity would turn tail and fly. Such submersibles would require a good surface speed, but submerged their rate of progress would be a matter of small importance.

Much more did the courteous Colonel tell me, but the above is all I feel inclined to publish of the many details, and much

information he so kindly gave me. I am sure, emanating from so noted an expert, the above will have more than ordinary interest.

FLACH'S SUBMARINE BOAT.

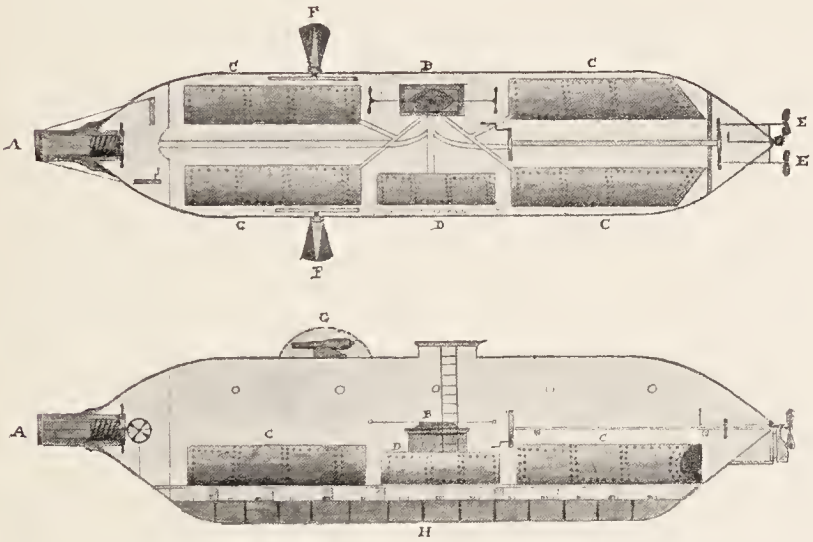
By Hamilton Williams, M.A.[1]

(Instructor to Naval Cadets in H.M.S. Britannia.)

In the year 1866, during the war between Spain and Her late Colonies of Chili and Peru, a German, named Flach, living in Valparaiso, designed and built a submarine boat for the express purpose of making an attack upon the Spanish squadron then blockading that Port. She was cylindrical, of sheet iron, tapering to a point at each end, being about 40 feet long by eight in diameter. She was propelled by twin screws worked by hand, which at the most only gave her from three to four knots. Within her, connected by an air pump, were four large iron cylinders, filled with compressed air, while a smaller cylinder was charged with oxygen for the purification of the foul air when she was below the surface. She had but a small margain of buoyancy, and the fins on her sides were the means to which her inventor looked for making her dive beneath the surface. In the plan they seem singularly inadequate for such a purpose, nor is it easy to comprehend in what way they exercised the power which they were supposed to possess. On the other hand, should they fail her when she was required to ascend to the surface, she was able to divest herself of a heavy iron keel in fourteen distinct pieces, any one or all of which could be dropped from within at will. Her mode of attack was somewhat different from that usually adopted for such vessels. She carried no torpedo, either spar or automobile, but she was in fact herself at once a submarine boat and a torpedo. For, built into her framework, so as to

1 Mr. Williams was an eye-witness of the occurrence herein related.—Author.

form a portion of the vessel itself, was a short breech-loading gun throwing a shell of 40 lbs. weight, charged with guncotton. As may be seen in the plan, a cap fitted over the muzzle of this gun and could be removed from within when the gun was loaded and the shot was to be fired. For defence, when moving on the surface. she carried a small breech-loading gun, which was covered by a metal cap when under water. Her inventor and a friend had on more than one occasion taken her out in the Bay for short trial trips, when it was understood that she had answered all expectations, and at last on the 3rd of May, 1866, he determined to give a public exhibition of her powers.



CCLXVII.-CCLXVIII. FLACH'S SUBMARINE BOAT

A. Short breech-loading gun of 40 lbs. to be fired under water.
B. Air-pump.
C. Four cylindrical cases filled with compressed air.
D. Cylindrical case filled with oxygen.
E. Twin screws, worked by hand.
F. Fins to assist boat in rising or descending.
G. Small rifled gun under air-tight case which is removed when on the surface.
H. Iron keel in 14 equal parts, which could be dropped separately or together in case of necessity.

She was to dive beneath the surface, traverse the breadth of the Bay (about five miles) under water, then rise to the surface, fire her gun, and return in full view.

Herr Flach, confident like too many other inventors in the success of his craft, took his son with him and six other people. At the moment of embarking an American Whaling Captain

quietly made fast a long thin line to the submarine boat, but Flach angrily cut it with his knife and then lowered himself, last of all the crew, down the narrow manhole, screwed down the cap and began the fatal trial. The spectators saw the two screws disturb the water astern, the half submerged boat moved sluggishly forward for a few yards, then her fore end dipped, her body slowly inclined downwards, and she disappeared from view.

All the rest of the day the far side of the Bay was eagerly scanned to hail her reappearance, but hour after hour passed and nothing was seen of her. However, by nightfall, it was rumoured that she had come up, and was slowly returning to her buoy. Next morning, nevertheless, she was not at her accustomed moorings, nor was anything known about her until a boat proceeding to the mole from H.M.S. 'Leander,' then lying in the Bay, noticed a stream of air bubbles rising continually to the surface at a very short distance from the spot where the submarine had dived. It was at once evident that she had almost instantly gone straight down to the bottom and had never moved since. Although the depth was very great, 27 fathoms, far too deep for diving safely, men from the 'Leander' volunteered for the work of attempting to raise her, and at great peril managed to get hawsers round her as she lay with her nose buried in the mud. The hawsers, however, proved too weak to lift her great weight, and carried away when the strain was put upon them, and it was proposed to use chain cables instead, but before these could be secured round her, the 'Leander' received urgent orders to leave at once for Callao, where the Spanish fleet had already engaged the forts protecting the town, and where a British Ship of War was required for the protection of British interests.

The attempt was therefore abandoned, and it has never been possible to know what mischance it was which caused the disaster, by which the unfortunate inmates met their death, for Flach's submarine boat still lies at the bottom of Valparaiso Bay, at once an iron failure and a shroud.

SUBMARINE NAVIGATION

AN INTERVIEW WITH MR. A. F. YARROW.[1]

The doings of the 'Gustave Zédé' are exciting so much interest in France—and in the columns of the London papers—just now that a *Westminster* representative a day or two ago betook himself to the Isle of Dogs to hear what Mr. A. F. Yarrow, as one of the greatest English experts in the building of torpedo-boats and other strange craft, might have to say upon the matter.

'What is your view of the latest French development of the submarine boat idea?' he was asked.

'From the sensation which is being made about it in France,' replied Mr. Yarrow, 'one would think it was a new idea. It is not. For more than thirty years trials have been made of submarine torpedo-boats. And the thirty years have been marked by little progress and considerable loss of life. And in this latest attempt by the French the essential objections to the idea still remain. First of all, these boats are so dangerous that I doubt if competent man will be found willing in time of peace to risk their lives in the necessary practice. Many competent constructors could be found ready and willing to build one of these boats, but I am quite sure not many would venture in it when it was built. There may be some who, unaware of the risk, would consent to make a trial, but I much question if the abler and better-informed men, who know something about the subject, and who would really be required to work the boats properly, would do so any more than I would. Indeed, I should never ask any of my men to do it. These dangers arise to some extent from the fact that the specific gravity of the boat must be either exactly or nearly the same as the specific gravity of the water. The result is that if an indentation was caused in the skin of the vessel, its specific gravity would of course become actually greater than that of the water, and it would sink to the bottom. Another danger, which arises chiefly in shallow water, is that the vessel is apt, through the slightest disorder of the steering gear, to get out of the horizontal line. And in that case in less than no time it might stick its head in the mud.

1 From the 'Westminster Gazette.'

This actually occurred a few years ago at Tilbury, when Lord Charles Beresford was nearly drowned.

'A third danger is that of collision with rocks, fish, or pieces of wreckage. If a large fish in some foreign sea came into contact with one of these boats it might easily take charge of the steering gear.'

'But supposing men were found who were willing to take these risks, and that no mishap occurred, what do you think would be the value of such boats?'

'In my belief,' Mr. Yarrow replied, 'they could be of value only against stationary vessels. In the case of a vessel in motion, sufficiently accurate guiding would be impossible. As far as stationary vessels are concerned submarine torpedo-boats which have come happily through the dangers which their own nature and construction involve, might conceivably be of some use. But as far as I can see we already possess something which is quite as effective as these boats, while at the same time the use of them does not involve the risk of the lives of a crew of brave men. I refer to such a torpedo as the 'Brennan,' which can be guided by electric wire from the shore, and is capable of terrible effect in all cases of blockade.'

'Then, Mr. Yarrow, you are not concerned about this movement in favour of submarine boats on the part of the French?'

'With our present knowledge,' was the reply, 'they are both dangerous and ineffective, and, I may add, the more money the French spend upon them the better for the rest.'

AN INTERVIEW WITH MESSRS. THORNYCROFT.[1]

The question of submarine boats is one that can no longer be dismissed with contempt. The French are evidently satisfied with the experiments they have made, and in their Naval Estimates for the coming year money is provided for the construction of a small fleet of submarines. The Americans,

1 Extracted from 'Daily Graphic,' November 10th, 1900.

also, have been experimenting, and claim to have achieved results even more valuable than the French. In England little has yet been done. It may be assumed, however, that men, whose main business is the designing and construction of small fighting craft, have not ignored the question. A representative of the *Daily Graphic* has, therefore visited some of the principal firms of torpedo-boat builders to ascertain their views as to the value of this new type of ship. The first firm visited was that of Messrs. John Thornycroft and Co., at Chiswick.

'On one point I can speak with confidence,' said Mr. Thornycroft. 'I would rather not go in a submarine boat myself. And that being the case,' he added more seriously, 'I feel reluctant to put other men on board such a craft.'

'Your ambition is rather to build boats that will keep on the surface?'

'And it is a sound ambition, too. I have no desire to soar in the air or plunge under the water. To put it mathematically, I am content to move in two dimensions. The X and Y ordinates are amply sufficient for all my travelling. I prefer to leave Z alone.'

'But if other Powers decline to leave Z alone! If they persist in building boats which can travel under the water, ought not we to be prepared to meet them?'

'We certainly ought to watch very carefully what is being done in the matter by foreign navies, and I have not the least doubt that the Admiralty is watching. But even if the French submarines are as successful as they are said to be, it does not follow that we ought also to build submarines.'

'Why not?'

'Because you cannot fight a submarine with a submarine. How we are to fight them is not yet quite clear, but I imagine our object will be to drop a shell into the water so that it will explode in the neighbourhood of the submarine boat, either level with it or below it. The shock from the shell, transmitted through the solid water, would then infallibly crumple up the boat.'

'Is it possible to time a shell so that it shall explode at a given depth below the surface?'

'There is not much difficulty about that. Nor need the

shell be an exceptionally powerful one. A submarine boat must be built of such slender materials that a moderate shock in its near neighbourhood would completely disable it.'

'But you have got to see your submarine first?'

'That's the rub; but the possession of a submarine of your own won't help you to see the enemy's submarine. On the contrary, one great weakness of the submarine boat is the difficulty of seeing anything at all from it.'

'I thought there was some contrivance with a system of lenses at the top of a tube rising above the water?'

'There is, and I believe it is fairly good, but it cannot be so good as a man in the open on the look-out with a telescope. My point is that one submarine could not help us to see or to fight another submarine.'

'But might it not be worth our while to have submarines to attack the enemy's ships?'

'That entirely depends on the range of action of submarine boats. At present their range is very limited—a few miles at most. Therefore, their main, if not their only use, would be for harbour defence against a blockading squadron. But as long as we maintain command of the high seas the enemy's vessels cannot blockade our harbours; it is we who shall be trying to blockade theirs.'

'Is it not possible, however, that the submarine may be so developed as to take part in open sea warfare?'

'I do not think it is likely. The submarine has to work under special conditions, which must handicap it in relation to other vessels, both with regard to speed and to range of action.'

'Do you mean that a submarine boat must travel slower because the resistance under water is greater than on the surface?'

'No, that is not the explanation. The resistance, on the contrary, is less for a completely submerged body, because no waves are created. The water that is displaced in front simply closes in behind and helps to push the body forward. A boat moving on the surface throws out waves in front and on either side, and that means an absolute loss of energy. You will find that for this reason a 'Whitehead' torpedo travels faster under the water than on the surface.'

'Then why must submarine boats always be slower than floating boats?'

'Because they cannot expend the same power on their propulsion. The most compact source of power we possess is coal. But to burn a ton of coal requires twelve tons of air. Therefore, obviously, coal is impossible on a submarine. Other sources of power, such as compressed air and electricity, are relatively very heavy, so that the submarine is at once placed at a very great disadvantage.'

'Is it not possible, however, that electrical storage batteries may be very greatly improved?'

'Undoubtedly it is possible, and if we could discover a storage battery lighter than coal a good many problems would be solved. But the submarine boat would still be at a disadvantage. The Americans seem to me to have the best type of submarine that has been yet worked out. Their latest boat is rather a diving boat than a submarine. It travels upon the surface until it wishes to avoid observation, and then dives below. But even this boat is subject to a heavy handicap. In order to possess diving power it must be constructed in a manner which makes it unfitted to keep the sea in the same way as a vessel that is intended only to float.'

'You are inclined to think, then, that submarine boats, or rather diving boats, may be useful for harbour defence, but certainly not for fighting on the high seas?'

'I would not like to commit myself,' said Mr. Thornycroft, cautiously, 'even to harbour defence, I do not feel yet satisfied that the problem of keeping a level keel under water has been solved. A slight mistake on the part of the crew, or a breakdown in some automatic machinery, might at any moment deflect the boat upwards or downwards. If upwards, not much harm would be done; if downwards, and the boat were moving at any considerable speed, a few seconds would carry it either to the bottom, or to water so deep that the pressure would crush the boat as one crushes an empty egg-shell. If ever I have to go under water with a submarine boat,' said Mr. Thornycroft, in conclusion, 'I should prefer to sit outside, so as to be able to get off quickly if anything went wrong.'

SUBMARINE NAVIGATION

A COMING REVOLUTION IN NAVAL WARFARE.[1]

By Sir W. Laird Clowes.

During the nineteenth century three factors arose successively to revolutionise naval warfare. The first was steam; the second was armour, bringing with it the high-powered gun; the third was the 'Whitehead' torpedo. It is an historical fact that the Admiralty displayed great unwillingness to recognise each of these innovations. I am afraid that it is now displaying corresponding unwillingness to recognise an innovation which is destined to be far more revolutionary than any of them. Otherwise it would scarcely have decided last autumn to begin experimenting with submarine boats.

In the course of the century there were ninety-nine years in any one of which the Lords of the Admiralty would have been justified in ordering the construction of submarine boats for experimental purposes. There was but one year in which any action of the sort was unjustifiable. It was the year 1900. Yet my Lords chose it for the purpose; and, after having proclaimed more than once their conviction that submarine boats were useless, stultified themselves by commanding the building of four craft of the sort. I do not know why they ordered four, all of the same kind; for, seeing that the vessels were required ostensibly for experimental purposes, one, or at most two, of a kind would assuredly have been sufficient to begin with; and when ordering four, it would undoubtedly have been wise to secure specimens of two or more types; for it cannot be contended that the 'Holland' type, which alone is to be reproduced for the Admiralty to experiment with, is very much better than certain other types, even supposing the 'Holland' type to have accomplished all that is claimed on its behalf.

I do not, however, desire to dwell upon this phase of Admiralty eccentricity. My point is that, when the boats were ordered, the time had gone by for experimenting with submarine boats. To my mind, Whitehall was perfectly right in

[1] From 'The New Liberal Review,' June 1901, No. 5.

omitting to build submarine boats before 1900. Several other countries had wasted money on them, only to find themselves confronted with difficulties which appeared to preclude the possibility of submarine boats being used in warfare without being much more dangerous to their crews than to their enemies. At least one other country had used submarine boats in warfare, and had learnt by bitter experience the risks of doing so. In 1900, when the Admiralty boats were ordered, nothing fresh had come to light to induce the belief that the numerous complicated problems connected with submarine navigation were nearer solution than they had been five or ten years earlier. France has built several boats since she launched the 'Gustave Zédé' in 1893; but there are no grounds for supposing that she has greatly improved upon that vessel. The original 'Holland' boat, prototype of the craft which are now building, was constructed more than ten years ago; and even the modified 'Holland,' which is suspected of being the parent of the Admiralty's young hopefuls, has been four years in existence. Why my Lords did not, apparently, awake until 1900 to the fact that Jules and Jonathan were playing with submarines boats; and why they then instantly ordered four of Jonathan's, yet wholly ignored Jules,' are points too hard for me to attempt to explain. But I believe that I can show excellent reasons why they ought not to have done this thing. It is not only that little or no practical progress was made in the last years of the nineteenth century towards the solution of those various problems which must be solved ere submarine navigation can be rendered even approximately safe or certain. A much more important consideration is that, before the Admiralty ordered its four boats, discovery had shown how all the most crucial problems connected with the subject might be, not solved, but evaded. It had been proved, I mean, that all the important results sought to be attained with submarine boats could be attained without them; and that it was no longer necessary to struggle with such difficulties as the question of seeing under water, the question of preserving the longitudinal stability of an immersed vessel, in which men are moving about, or from which it is desired to discharge torpedoes, and the question of securing the safety of a submarine's crew.

In order that I make myself clear, I must put forward some definitions before I proceed.

There are several types or families of vessels which are designed to move under water. The submarine boat is the oldest of them, a craft of the sort having been built as early as the first half of the seventeenth century, if not before. By 'submarine boat' I mean a craft designed to be navigated beneath the surface of water by the agency of a human crew contained within her body. Then there are the various torpedoes; the 'Whitehead' and its congeners—called automobile torpedoes—which contain no human crew, but which have within them not only their own motive, but also their own steering power; and the mechanically controlled torpedoes of which the 'Brennan' and the 'Sims-Edison' are types. Automobiles, when they have once been started on a course beneath the water, cease to be under the direction of him who has discharged them. They run, more or less accurately, on their assigned way at an assigned depth; and, if they do not hit their mark, they are either lost or picked up and brought back by persons sent to fetch them. The mechanically controlled torpedoes, or, as I would prefer to call them, the dianemic torpedoes—since they are governed from a base by means of a wire or wires, with or without electrical devices—have the advantage of being dirigible in any desired direction, and if unexploded, of being capable of being brought back again to the starting point. In fact, within certain limitations, they can do some of the work of the ideal submarine boat. But they have grave disadvantages. They are governed, as has been said, by means of wires; and wires may be cut, or may be sources of entanglement to the screws of friendly vessels. Moreover, they can be worked only with comparatively cumbersome and expensive machinery, and from a quasi-permanent base. Their employment from on board a ship under way has been adversely reported on. Their range, too, on account of the weight and drag of the wire attached to them, is restricted, and does not extend to anything approaching the limit of vision.

There is yet another type of vessel designed to move under water. For the sake of distinction, as well as of description, I will call it the 'Actinaut,' since it is governed, not by a human

crew, not by inherent forces, not by wires, but by 'rays.' I use the word rays; but I do not desire to limit the sense to 'rays' or 'waves' of any particular kind. They may be waves of ordinary light, and electrical oscillations, ultra-violet rays or kathodic rays. To put the matter briefly, and at the same time comprehensively, it may be said that the 'Actinaut' is to the dianemic torpedo what wireless telegraphy is to the older telegraphy. The essential point is that the 'Actinaut' can be steered, manœuvred, and exploded from a position with which it has no tangible or material connection, and from which its action may be controlled to a very considerable distance. It is immaterial whether its motive power be in itself or extraneous to itself.

On February 18 last, the *Daily News* informed its readers that 'Mr. Tesla suggests that it will be easy to build an automatic torpedo, which will be entirely under the control of the electrician, who, on shore, or in the conning-tower of a battleship, guides its course from his dainty keyboard till it successfully lays its half-ton of dynamite against the side of the hostile vessel.' And a Washington telegram of April 4 to the *Daily Mail* runs: 'Lieutenant Fiske, of the United States Navy has been granted a patent for a torpedo operated and steered solely by wireless electrical power directed from a central station ashore or aboard ship. The torpedo is under control until it hits the target and explodes. The torpedo is moved by electrical energy, known as Hertzian waves, and utilised by Tesla in recent wireless telegraphy experiments.' I have no present means of knowing the date or particulars of the patent of Lieutenant Fiske, whom I take to be the well-known Amercian scientific officer, Bradley A. Fiske; but, so far as can be judged, not only is the idea not new, but also the objects sought to be attained by Fiske's patent have been actually attained two or three years ago in Europe. These are covered by various patents, British, German, American, French, Swedish, Canadian, Austrian, Hungarian, Italian, Spanish, Danish, etc., which have been granted to Mr. Axel Orling and Mr. J. T. Armstrong, and which may be called the Orling-Armstrong patents.

The history of previous developments of the aetheric agency to which these patents have reference, is much older than is

usually suspected, and is well summarised by Mr. E. A. Goddin.

The first person to conceive the idea of establishing aetheric communication seems to have been the Spanish physicist Salva, in 1795. Salva's aim was no more ambitious than the discovery of a means of transmitting signals to distant places, and there receiving them, without the employment of material connections. He spoke of the possibility of effecting that result by utilising the flow of electricity through the earth, between two spots on its surface, charged positively and negatively, respectively. Many other physicists have worked upon those lines of research. Some have tried to attain their end by charging the earth with electricity at the transmitting station, and tapping the earth at points of different potential at the receiving station, where the flow of current between the points was indicated by a galvanometer. Some have employed as transmitter a grounded circuit, with earth connections at a considerable distance apart; and, as receiver, a similar circuit, with a galvanometer, in place of the battery. Electromagnetic induction has been also tried; and, in 1891, static induction was employed; but no system was found to be effective, save within limited range. In 1883 Professor Dolbear employed a transmitting apparatus, in which one of the terminals of the secondary open induction coil was led to earth, while the other was connected with a condenser of large capacity, provided with discharging points at its opposite terminal; and the receiver was similarly connected with the earth and with another condenser. By this arrangement, any alteration in the potential of the ground at the transmitting end resulted in a similar variation at the receiving end. Dolbear also employed in a similar manner a primary circuit, one terminal being grounded, while the other was exposed to the free air, or connected by a fine wire with a kite. He was, therefore, the first to utilise a circuit employing the air as one conductor, with the earth as a return. He appears to have used electromagnetic waves; but it was not until a few years later that Hertz published the result of his researches into their nature, and showed how their presence might be detected. Following this, Bromley produced his detector, which had been used previously by Varley for another purpose; and others,

including Lodge and Marconi, introduced further improvements, which constitute the present coherers, and which provide means whereby electromagnetic waves can be excited, and detected at a distant station. Wireless telegraphy has been the outcome of all this.

As long ago as 1892, Sir William Crookes expressed the opinion that among the things remaining to be discovered was a more delicate receiver, which would respond to wave-lengths between certain definite limits, and be silent to all others. The Orling-Armstrong patents seem to have been the first to achieve this desideratum. That is the key to a problem, the solution of which renders it, so far as I can see, useless to persist in wrestling with the numerous difficulties that must be overcome ere the submarine boat can be of any practical value as an engine of war; the Orling-Armstrong patents relate, generally, to means and apparatus connected with the reception and transmission of electromagnetic impulses, light, and invisible and other waves and radiations for the purpose of controlling the steering mechanism of torpedoes and other submarine vessels, and of effecting various operations from a distance without the employment of wire or other material connection. More particularly, the inventions comprise:—

(a.) Improved means of propagating electromagnetic waves, and of giving them a definite character.

(b.) An improved receptor, or aerial conductor, whereby the transmitted waves are conducted to the receiving apparatus without the employment of an erection requiring rigid support, which, fixed to a torpedo or other light craft, would give rise to instability.

(c.) Improvements in detectors, possessing great sensibility to the transmitted impulses, and susceptible of such construction as to render them responsive only to waves of a definite character.

(d.) A thoroughly efficacious means of restoring the detectors to their normal condition, after the reception of such waves.

(e.) General improvements in the receiving apparatus, whereby local disturbances, which impart false impulses to the receiver, are either prevented or rendered ineffective.

(f.) Improved means by which the desired one or more of a series of relays may be actuated with certainty by one receiving apparatus.

(g.) Means by which a torpedo or other craft may be caused automatically to follow the course of a beam of rays.

By applying these inventions practically in suitable combinations, an automobile torpedo, or a submarine vessel containing motive power, after having been started, may be controlled and regulated on its course by a distant operator, on shore, on shipboard, or even in a balloon; and he can stop or reverse its propelling machinery, lock or release its pistol mechanism, and effect with certainty as many other operations as may be required—all without the employment of wire or other material connection.

My contention is that, knowing of these inventions, and of the experiments which have been made with them, the Admiralty was not justified in pursuing the will-o'-the-wisp of the submarine boat, but should, instead, have followed up the clue, the end of which has been supplied by the ingenuity of the young Swede, Axel Orling, and the knowledge of Mr. J. T. Armstrong. I do not say that all the Orling-Armstrong inventions are absolutely perfect, and cannot be greatly improved upon. No doubt they may still be much developed and bettered. But they are relatively speaking, in a condition as advanced and practicable as were Mr. Louis Brennan's inventions, when they were first taken up by the Government eleven or twelve years ago, or as were Mr. Whitehead's inventions in the early seventies. It is fully manifest that they occupy the ground over which progress must be made in order to attain the objects which it has long been sought to attain by means of the submarine boat; and it is equally manifest that the submarine boat is, for the present at least, a mere red-herring on the path. The automobile torpedo and the dianemic torpedo have been good servants within their limitations; the submarine boat has, so far, been little more than a scientific dream. Nothing is more certain than that the former engines must be superseded, and the latter engine rendered unnecessary, by the introduction of what I have ventured to call the 'Actinaut;' which may be as small

or as large as you please, which does not imperil the lives of those employed in working it, which can be worked with accuracy by day or by night, so long as the object to be attained can be seen by the operator, and which is withal very inexpensive. It is important to add that the Orling-Armstrong inventions can be fitted to existing automobile torpedoes, such as the British 'R.G.F.,' the American 'Howell,' or the German 'Schwartzkopf,' and that these torpedoes are thereby transformed into actinauts at comparatively small cost.

The first practical demonstration of the principle of these inventions took place at Stockholm, in December 1898, in presence of King Oscar, who has interested himself very keenly in the matter; and, last year, actinauts were run successfully both in Sweden, and at Portsmouth, over distances of two and a half and three miles respectively. There is very little doubt, however, that actinauts can be controlled over much greater ranges. From the summit of a cliff, from a masthead, or from a balloon, a range of fifteen or twenty miles seems perfectly attainable. The apparatus worked by the controller is light and portable, measuring only 19 inches long, by 7 inches broad, and 8 inches high. There is plenty of room for it, therefore, in the smallest military top of any warship afloat; and it is so simple that the average coastguardsman can manipulate it after very brief experience.

I believe that I am right in saying that Messrs. Orling and Armstrong have been in treaty with the Admiralty with a view to obtaining, for experimental purposes, specimens of some of the numerous obselete 'marks' of 'Whiteheads' that are in store at Portsmouth and elsewhere. In these circumstances, the inventors, who already possess their own actinaut torpedo, are having one or more small submarine boats specially constructed for use as actinauts. It is to be hoped that when these are ready the Admiralty will devote the most serious attention to them, and, through the scientific officers of the 'Vernon' will endeavour to utilise for the public benefit the germ, if not indeed all the details, of the system. The fact that Lieutenant Fiske, the inventor of the famous

Range-Finder, has taken up the subject bears strong testimony in favour both of its importance and of its practicability.

It should be said, incidentally, that the Orling-Armstrong inventions afford the means of defining with the greatest accuracy the locality of a ship or lighthouse at night, by day, or in a fog; and that thus a vessel provided with the necessary apparatus is relieved from all risk of collision at sea; but that is a point which, though of immense importance, I am not immediately concerned with. What I am most anxious to insist upon is that in building submarine boats at this time of day the Admiralty is wasting money in the pursuit of a false scent; and that, even supposing that the principles of the actinaut are much less developed and perfected than I believe them to be, they are nevertheless the principles which, if persistently followed and studied, will lead the authorities in the right direction.

Nor is this all. I am inclined to see in the actinaut the beginning of an even greater revolution than any we have yet witnessed in naval warfare. The automobile torpedo is of limited range, and, when once it has been started on its course, is beyond control. The dianemic torpedo cannot be employed with safety from on board a ship under way, and cannot, indeed, be employed from any station where there is not a quasi-permanent installation of machinery. The gun itself is of less power and usefulness than the actinaut, which, besides possessing a greater effective range, does not depend upon the initial aim, but can have its progress altered and corrected up to the very instant of impact and explosion. Of course, a gun may sink an advancing actinaut, if its projectile can hit an invisible object; but I do not see how otherwise the machine can be stopped. The force directing it cannot be intercepted or cut off; and the actinaut, like the existing 'Whitehead,' may be supplied with net destroying and other adjuncts, which shall enable it, if not to force its own way through obstacles, at least to open a passage for other actinauts, which may follow the first as single spies or in battalions.

SUBMARINE NAVIGATION

SUBMARINE TORPEDO-BOATS.

By William W. Kimball.[1]

Although the land animal man has for untold years been in the habit of going to and fro upon the face of the waters in vehicles of his own construction, he has always been very chary about moving down into it in any kind of fabric. He connects going under water in a boat with drowning, and therefore is rather willing to conclude that submarine navigation has difficulties too great to be overcome to any practical degree, that little difficulties are very great ones, and that if some success be attained it can be put to no practical use.

The unhappy submarine navigator is always told, 'You can't see and you can't breathe under water, and if you could, a submarine boat would be only a toy.'

It is true that there is no way of seeing through water for any practical distance ahead; but on the other hand, a course can be steered under water by compass as readily as upon the surface on a dark night or in a thick fog.

There is no difficulty whatever about providing enough compressed air to keep the boat perfectly ventilated for days, and it is certain that very valuable military results otherwise unattainable can be had by utilizing water for cover against gun fire in the approach afloat, for the same reason that earth cover is used for the same purpose ashore.

At least three hundred years ago attempts were made to solve the problem of submarine navigation, and at nearly the same time attempts were made to provide practical breech-loading fire-arms.

One hundred years ago the practicability of devices to make both successful was demonstrated, but utterly failed to be recognised. The breech-loading firearm has been in general use for forty years. Perhaps the demonstrated utility of the submarine is about to be recognised.

During the Revolution, Bushnell, of Connecticut, grasped the main principles of submarine navigation. He built and operated a submarine boat that functioned as well, comparatively, as did Stephenson's first locomotive. He navigated in

1 From 'Harper's Magazine.'

New York Bay, placed his boat under the bottom of a British frigate, and only failed to attach his torpedo because the wood screw used for the purpose met a copper bolt in entering the hull, and of course failed to hold. He designed a boat slightly lighter than the water she displaced when totally submerged, pulled her forward with a hand-turned propeller, worked by her one-man crew, and forced her under by a vertically acting propeller. But his marvellous mechanical success made no impression at the time. He was one hundred and twenty-odd years ahead of the world—perhaps more.

Fulton built and used in France a submarine boat that he manœuvred well below the surface in the time of Napoleon; but it was rejected as impracticable, just as, at the same time and in the same country, a gun was rejected that had all the necessary features of a modern breech-loader. So Fulton dropped the development of his submarine craft and turned his attention to steam-boating.

The principal difficulties met with to-day in designing a submarine torpedo-boat are as follows:—Providing for sufficient stored power of a kind that can be economically expended in driving her when submerged; devising a good method of directing her toward an object constantly changing its position; installing an efficient armament; retaining a fixed centre of gravity and fixed weight in spite of exhaustion of stores and movements of weights; modelling her to meet the physical requirements of crushing strains and the tactical requirements of handiness; ballasting and trimming her so that she will have sufficient stability, and at the same time move readily in obedience to both horizontal and vertical rudder efforts.

No practical power for turning a propeller is known that does not use air in its generation. In a submarine, when running submerged, no supply can be drawn from above water, because any kind of an air-duct projecting upward from the hull would hamper facility of movement, would limit the depths of the dives, would show her location to the enemy, and would offer the enemy an easily attained and most vital point of attack.

Steam generated under water by burning fuel is out of the question, because the amount of compressed air that can be

stored for use in combustion is so small, and because it is so difficult to dispose of the products of combustion. In the 'Nordenfelt' submarine boats steam has been used for submerged work with a fair degree of success, by taking down a large quantity of superheated water and drawing the steam from it until the water cooled. Gas-engines fed by petroleum products have been used by Holland in some of his earlier boats, but his expenditure of power was limited, not so much by the amount of fuel he could carry as by the amount of compressed air he could store to mix with the gases in the engine in order to obtain working explosions in the cylinder. At present the best available source of power for submerged work is electricity drawn from storage cells; it is the one generally adopted, and will probably continue to be the best for some time. There are many attractive features about liquid air, and it may be rendered serviceable for the required purpose, but the making, storing, and renewing the store of it in a submarine seem difficult to the writer—perhaps only because he is not well informed upon the subject.

The 'Gustave Zédé,' the French submarine boat regularly in commission in the navy, upon whose performance was based the building of six French boats now in hand, is propelled by stored electricity. The weak point of the 'Zédé' is that she has no means within herself of renewing her store of power for submerged work, and that therefore her 'radius of action'—*i.e.*, the distance she can move from a base of supply—is very limited. At the time she was designed storage batteries were very crude, compared with what they are to-day, and although her large size, over 250 tons, would point to much better results if modern storage cells were provided, she is credited with a radius of action of only thirty miles. With the best electrical appliances in a boat of the most efficient size—somewhat less than 100 tons, as will be shown hereafter—it is not possible to store enough electricity to give more than about fifty miles' radius of action at a speed of eight knots. The radius will of course decrease with increase of speed, and slightly increase with decrease of speed; in other words, a boat can be kept in fighting trim at full speed for about six hours, and at the varying speeds of a coast-defence fight from sunrise to sunset.

A boat might need all this power and more in an action, since while within range of hostile gun-fire she must be always ready to dive, and must therefore be constantly sealed up, and consequently she must draw from her stored power from the beginning to the end of an action. She should be able, moreover, to move on the surface hundreds of miles to a field of action, and be ready for work on arrival. These considerations necessitated the adoption of two kinds of power—one which could be used for driving a boat a long distance on the surface, and for keeping her stored power always at a maximum meantime; and the other, the stored power for submerged work within the range of hostile guns.

Nordenfelt used steam from a coal-fired boiler for surface work, and after dousing fires, taking in water ballast, and sealing up preparatory to going under, the steam from the hot water in the boiler was ready for submerged work.

The new French boat, the 'Narval,' that is to have a half-dozen sister boats, has a petroleum-engine for surface, and storage-battery electricity for submerged running.

The 'Holland,' an American boat, uses a gasoline-engine for surface, and stored electricity for under-water work. Her surface radius of action is a good 800 miles, and her submerged one about fifty. The large dynamo is run by her gas-engine to store electricity when the boat is on the surface; and when going under, the gas-engine is thrown out of gear and the dynamo is used as an electric motor, taking current from the cells it has stored. For auxiliary power, necessary for blowing out water from ballast-tanks, operating steering-engines, working the battery, moving weights, etc., compressed air is readily available, and is so used by Holland, and is probably made use of more or less by the French.

To steer the boat when submerged, a compass or gyroscope may be used, or some method of obtaining, by means of a camera-lucida, reflected image of the object steered for. All attempts at lighting the water ahead by strong electric arc-lights have proved futile, because the penetration of the light ray through water is too slight for practical use in navigation, and would be tactically bad even if it had sufficient penetration, since it would reveal the position of the boat to the enemy. The arc-light may, and probably will, be useful for

under-water work in connection with mines and wrecks, in such constructions as the Lake boat the 'Argonaut' in the United States, and the 'Travailleur Sous-Marin' in France, which are not designed or adapted for submarine torpedo-boat duty.

In the early days of experiments with metal submarines, the effect of the 'heeling error' of the compass, due to the varying inclinations of the craft in diving and rising, was little and the general compensating of the compass not fully understood; when the compass showed lack of reliability, it was attributed to some mysterious effect of submergence. Compasses can be, and are, sufficiently compensated for fair work in submarines. Of course, no compass can be expected to act perfectly when installed where it has magnetic metal near to and all about it, as in a submarine's conning-tower; the conditions, however, are no worse than in the compass positions in a battleship's conning-tower, or in her below-decks tiller room. The gyroscope, in its present stage of development, offers no advantage over the compass.

A camera-lucida tube may be run up from within the boat so as to be useful for reconnoitring when moving slowly, but when moving at speed it interferes with manœuvring—the quick movements of the image, due to the motion of the boat, confuse the eye; it is difficult to place it in a convenient position near the conning-tower, and it does not quickly give an all-around view. For these reasons submarine men generally favour rising to the surface for a few seconds, at the risk of exposing a few inches of armoured conning-tower. Without taking observations from the surface in some manner there is no known way of steering for an object whose speed and direction cannot be predicted, as, for instance, a hostile ship in action.

The armament of a sixty to eighty ton submarine may be made very efficient against any ship within the close range that the boat could work. The 'Holland' had originally an automobile torpedo-tube placed nearly level in the axis of the boat forward, an aerial torpedo-tube in the same vertical plane as the other, secured over it at a fixed elevation, and an elevated projectile torpedo-tube aft. In so small a craft the aerial torpedo-tube must be short, but it is sufficiently long

to give a thousand yards' range to a shell containing 100 pounds of guncotton or nitro-gelatine. Since it must be used over water the boat must show her conning-tower top and tube muzzle as she delivers; but as she would expose only a few inches of target for a few seconds, and in an unforeseen direction, and at an unknown range, the likelihood of her suffering under the present condition of gunnery is small enough to give her an excellent fighting chance. The use of the aerial torpedo was to give her more range than the automobile torpedo allows, which last cannot be depended upon to get home at distances greater than three hundred to four hundred yards under battle conditions. In delivering this last the conning-tower must show at four hundred yards from the ship, but even then the ship could hardly sink her before the torpedo was driven home.

The projectile torpedo astern, fired through water, cannot be depended upon for a range greater than one hundred yards. It is of use only at the moment of passing out from the shadow of a ship; for though one can see practically nothing when looking ahead through water, an object on the surface is always discernible by the shutting out of the sunlight from above. Whether the projectile torpedo is worth the room it takes is questionable, because, in the presence of submarines, ships would be likely to haul off; still, if the work in hand were such as to require the ships to charge home over the submarines, it could be readily delivered upward through the ship's bottom. The French submarine flotilla is to be armed with automobile torpedoes only, and the five boats of the 'Holland' type, lately authorized by Congress, are to have only the French armament.

The necessity of retaining a fixed weight when submerged springs from the fact that if the boat were allowed to grow lighter she would not dive so readily, and if heavier she would not rise so easily; in other words, she would lose manœuvring facility in the vertical plane. As for the centre of gravity, if it were allowed to move, she would grow more stable or less so, and would get out of trim.

It is therefore necessary to make all weights, except the crew immovable, and to compensate for all weights expended by taking in equal weights of water, whose centres of gravity

give practically the same trimming moments. There is, of course, no difficulty in fixing the position of rigid expendable weights, such as torpedoes. The immovability of the water in the large ballast-tanks is arranged for by always filling the tanks chock-up; the small tanks that are used for securing the necessary delicate balance and trim, are of such shape and so placed that the movement of water in them cannot practically alter the position of the centre of gravity of the boat as a whole.

The compensation for expended weights is provided for by mechanically arranging for the automatic receipt of equal weights of water. How far this matter has been attended to in the design of the new French submarines is not known to the writer; but in some of the earlier boats the water ballast was not fixed, and the natural consequence was that the boat stood on her stem and sat on her stern, much to the surprise and discomfort of her crew.

The best shape for withstanding the strain due to pressure from depth of water is, of course, the sphere, and this shape is adopted for the French bottom worker, the 'Travailleur-Sous-Marin;' but such a model will not manœuvre readily in either vertical or horizontal plane, is very slow for power expended, and would not at all fill the requirements of model for a submarine torpedo-boat. Considerations of strength, speed, and manœuvring qualities, and arrangement of internal space, have led to the adoption of the same shape for submarine boats, as is used for automobile torpedoes. The circular cross-section gives great strength, and the spindle-of-revolution shape lends itself to manœuvring qualities of all kinds.

Curiously enough, though experts can advise to a nicety as to bursting strains, there are no authoritative data on water-pressure crushing strains, and no expert in the world can positively tell what strength of material is needed to meet them. The factors of safety used for submarine hulls would seem to be ridiculously large, considering the depths the boats are designed to reach. There is, of course, no tactical necessity for going below the depth necessary to comfortably clear a deep draught battleship's keel.

The need of making a boat steer up and down readily limits her length to about six or seven diameters, and the need

for submerged work in four or five fathoms of water limits her diameter to about twelve feet, for she must have a little water over her, and must have a working clearance from the bottom. Therefore it would seem that the most practical dimensions for submarine torpedo-boats are about seventy to eighty feet length and twelve feet diameter. The French made the 'Zédé' much larger, but in the new boats they are approximating the correct dimensions, though the length is rather too great for good work, probably because they require space for generating power to furnish a speed which can be obtained only at the expense of handiness.

A submarine boat is easily given plenty of stability for surface work, for there is practically no side to make her roll in a seaway; the water meets little resistance in passing over. If in heavy weather the boat rolls, it is because she is riding light, and is showing too much above water; it is only necessary to drop her a bit, and the water will pass over freely. In very heavy weather combers might splash into the smoke-stack of a steamer and cause delay, but in a gas-engine boat there would be no harm in taking a little water down the air-tube. In any event, the worst that the heaviest weather could do would be to force her to seal up, ballast down to diving trim, and drift till the storm broke. The 'Holland' when in diving trim in a seaway does not roll at all, although she is as round as a bottle; but to one on board there is a curious feeling of side movement of translation as she slides down the back of a sea.

In order to dive, a submarine of practical design takes in water ballast until the remaining buoyancy can be overcome by the action of the horizontal rudders; then the boat is steered under as she moves ahead. And therefore it is very apparent that, given a rudder surface sufficient to steer the submarine under at slow speeds, varying speeds and varying rudder angles, will give a wide range in angular direction in the vertical plane, provided that the boat is not so long as to be slow in turning, and provided that her longitudinal stability is not so great as to make her sluggish about inclining her bow up or down.

This very simple method of control in the vertical plane is in use to-day in the thousands of successful submarine boats

that we know as automobile torpedoes, as well as in the few submarine boats proper, which in general principles of functioning differ from the torpedoes only in substituting directing brains for directing automata. In the torpedo the horizontal rudders are actuated automatically by the pressure of the water, which, of course, corresponds to the depth, and these thus steer her up or down until the depth she is set to run at is steadied upon; in the submarine boat the horizontal rudders are governed by the helmsman, who is guided by a depth gauge in front of his eyes; or, as in the torpedo, an automatic depth-finder may be thrown into gear.

Simple as is the method of steering a slightly buoyant boat up and down, it was arrived at only after many attempts in other directions. A number of boats have been designed to rise and sink at will by changing the amounts of ballast while keeping the bulk constant, or by keeping the weight constant, and varying the bulk by mechanical means. There is no great difficulty in accomplishing these methods of varying the specific gravity, but they are dangerous and non-effective. They are dangerous, because if anything goes wrong with her lightening arrangements when she is heavier than water, she will sink and be crushed by the water-pressure, whereas the buoyant boat would rise. They are non-effective because chances in weight cannot be made rapidly enough to give the quick working of the vertical plane that is absolutely necessary. For instance, when coming to the surface to get a look around within a ship's secondary-battery range, the boat cannot wait to take in ballast water and sink slowly from sight; she must be pushed under by the effort of her full motive power in the fewest possible seconds.

A large submarine boat, 'Le Plongeur,' built in France, in the middle of the century, to function by change of weight, made a most ridiculous exhibition on trial. She was ballasted to weigh slightly more than her displacement, and driven forward by her motive power. She sunk to the bottom in moving ahead, impinged upon it at a small angle, and as she weighed almost nothing she rebounded to the surface, and so went undulating along between bottom and surface.

Another, the English 'Nautilus,' was constructed to rise and sink by forcing out or drawing in hollow cylinders, which

would change the bulk, while the weight remained constant. Some official visitors took passage in her to the bottom of a dock, but when the operator wished to return to the surface the cylinders declined to out-thrust, because the power for working them, though amply sufficient for working in water, was not great enough to drive them into mud; and besides the adhesiveness of the mud had not been considered. She was finally ignominously hauled up by a tackle, and the official visitors did not enjoy themselves very much. The curious things about this trial are that it was made in England only a few years ago, long after the absurd inadequacy of the mechanism tried was fully understood, and that it is even now quoted in English service journals to prove the inefficiency of real submarine boats.

The 'Nordenfelt' submarines, built in Sweden in the last decade, embodied many excellent features, and would have been fairly successful had they been designed for diving instead of for rising and sinking. Nordenfelt's method was to pull a buoyant craft down by vertically acting propellers, and to aid the lift of buoyancy by the propellers in rising. The expenditure of stored power required to pull a boat perpendicularly against the resistance of her horizontal longitudinal section is enormous, compared with the slight effort needed to push her, bow on, down an incline in the water. Nordenfelt held the theory that it was dangerous ever to let the axis of a submarine depart from parallelism to the surface, lest she thrust her nose in the mud of the bottom and stick fast, or go too deep and be crushed. As a matter of fact no submarine can be held rigidly parallel to the surface of the water, and if it could it would lose all the advantages of quick manœuvre in the vertical plane possessed by a properly designed diving-boat. But Nordenfelt insisted that submarines must work on an even keel, and this idea, in spite of theory, practice, experience, and common-sense, was widely accepted. It has been most difficult to dislodge, because it was founded on faith, and could not be reached by physical proofs; but it is generally waning now, although still firmly asserted in England and Germany.

It was the basis of much false reasoning, in a lecture delivered by a high authority in naval architecture, at a meeting

of naval architects in Berlin last December. The learned lecturer concluded that if the submerged boat were depressed by the head a few degrees through movement of the crew, she would necessarily follow the direction of her axis, and reach a critical depth in a few seconds. This is like concluding that if a ship's head were thrown toward a neighbouring rock by a current, she would necessarily strike that rock in a few seconds—and so she certainly would if the pilot forgot that her helm was useful in such cases, and that her engines could be reversed.

The 'Holland' has been trimmed by the head about ten degrees, and in that condition has been run submerged for half a mile with a variation of only a few inches in the vertical plane, by using the horizontal rudder to meet the tendency to dive. Incidentally the same authority states that the weight of the water displaced is equal to the weight of the submerged boat, and thus shows that he forgets that all practical diving-boats are buoyant when submerged.

The chief difficulties in designing a submarine can all be satisfactorily met, except those of propelling power under all conditions, and of field of vision when submerged. She will be deficient in speed until a now unknown power be found, and she cannot retain her invisibility below the surface, and at the same time see her enemy without some discovery in the property of light that it is difficult to imagine. Although a submarine can be perfectly lighted by means of the storage cells, and perfectly ventilated by pumping the vitiated air overboard, and renewing the supply from the compressed-air tanks, she will be uninhabitable for long periods, owing to the cramped quarters; and the duties of the crew are so severe that the men must be relieved frequently.

The best submarine that can be built at present must be slow, more uninhabitable than surface craft, and of limited time endurance while moving in fighting trim; but with relief crews she can occupy indefinitely a position required by an enemy for blockade or bombardment, and by showing her camera-lucida tube or conning-tower top for a few seconds she can move up to a battleship in the face of her fire and search-light, day or night, and force her to move away or accept the probability of being put out of the fight by a craft rating three

per cent. of her cost, and one per cent. of her crew—a craft that neither gun-fire nor torpedo practice would stop.

With properly manned submarines in the defensive, blockades cannot be held nor bombardments attempted, and in attacking ports they will be useful in countermining the protecting mines and in entering unseen to destroy ships, dry docks, and buildings. When it was supposed that the 'Holland' might be used in the attack of the Havana batteries, enough qualified men volunteered from the navy to make up a dozen crews.

Submarines have never been tried in action. The Confederate torpedo-boat which sunk the 'Housatonic' off Charleston, was designed to work as a submarine, but was used only as a surface boat when she made her successful attack, and went down with her enemy, as any successful torpedo-boat may expect to do.

This is the one boat among fifty or sixty experimented with in the last hundred years that drowned her crew, and is the one much quoted to show the dangers of submarine navigation, although all accidents connected with her were due to the fact that she was used as a surface boat, and as such was of course inefficient. The submarine has arrived. The recognition of her capabilities within her limited field of usefulness cannot be much longer delayed. France has grasped the idea of the effectiveness of the type in general, and has so far developed it that she has a dozen submarines on her naval register, and has provided for thirty-eight all told. When she has employed them for coast defence sufficiently to make their potential felt, it will be apparent that she will be able to send her whole cruising fleet against an enemy's ships, ports, or lines of communications. Other civilized nations will then be forced to follow her lead, just as they did in the matter of surface torpedo-boats. Germany is yielding to the pressure of progress, and is to have a competition of submarine models at Kiel during the current year. Russia is at work on submarines, but her results are wisely kept secret. England discredits them as much as possible, for the same reason that she discredited surface torpedo-boats when they appeared. Her policy is quite correct, since, as the strongest Power at sea, she should in every way try to prevent the

appearance of craft that will so greatly limit the effectiveness of her present fleet. A year or two ago English service journals asserted that torpedo-boat-destroyers thrown out ahead of a fleet would readily destroy submarines as they rose to correct direction on the ships, though how this was to be done, when the submarines could readily dive under the destroyers and hold for the ship, was not explained. Later the English attitude was voiced in a discussion of an experimental French boat, published in an authoritative naval paper, as follows:—'The 'Gustave Zédé' may turn out to be a valuable adjunct for harbour defence; but even in that case it can only be the arm of the weak at sea, and thus finds no place in our arsenal of offensive weapons.' This view of the matter was supported by the First Lord of the Admiralty in answering an interpellation in Parliament, and amplified by the statement that since it was evident that submarines could not be met by submarines, the Admiralty was seeking some method of counteracting their effect.

The English press contains at present many suggestions to the effect that the British Admiralty should give the submarine question more serious consideration. Great Britain was forced to meet the inexpensive torpedo-boat with the expensive torpedo-boat-destroyer, and she will be forced to meet the submarine in some way not at present apparent. She accepts the truism that 'the best coast defence is the energetic attack of the enemy's coast,' and accordingly directs her policy toward the increase of her offensive military sea power. But she continues to provide shore fortifications and mobile sea defences, for the security of her wealth centres and strategic positions, and, as the most practicable feature for these last, she will provide submarines when other nations have brought them forward.

What the naval policy of the United States may be the writer does not know; and if he did he could not publicly discuss it. The newspapers show that the governmental development of the submarine has been dallied with in this country for a dozen years or more, generally encouraged by Congress, and generally opposed by naval officers, many of whom are inclined to follow the lead of England, and conclude that submarines are death-traps when they are not toys.

SUBMARINE NAVIGATION

Last November the 'Holland,' a submarine boat built by private parties and manned by civilians, fulfilled, on official trials, all the requirements that the Navy Department had laid down. Her sale to the Government was then proposed by her owners, and the proposition was reported against by the Board on Construction of the Navy. Finally she was accepted, and shortly after Congress authorized the construction of five more boats of the 'Holland' type.

Many naval officers, of standing, express the opinion that the mechanism of a submarine is too complicated to be successfully handled by our navy, that the type has no tactical place in naval warfare, and that the 'Holland' will soon find her way to the scrap heap. On the other hand, the Admiral, the Constructor-in-Chief, almost all naval officers who have seen the 'Holland' at work, and all who have been under water in her, favour submarines, and hold that a naval crew can do in the 'Holland' what a civilian crew has done, since the latter was drawn from the same class of men that fill many naval enlistments.

In the late war with Spain public opinion hampered naval operations, by requiring a portion of our fleet to be retained in the defence of our coasts. Evidently there must be some means of providing a coast defence. The United States cruising fleet is very small for the work that may soon be required of it; it will remain so for at least fifty years, and during that time we will sadly need submarines and surface torpedo-boats. But it is very doubtful whether the craft themselves and a rational organization for their use will be provided. In this country, where they are needed more than in any other in the world, surface torpedo-boats are discredited because a few Spanish torpedo-boats greatly terrified us during the Spanish war, and then failed to damage our fleet.

Submarines are beginning to gain a certain recognition here, but they have yet to meet opposition of many kinds, one of which was formulated by a man connected with armour manufacture, who declared: 'We will oppose submarines. For if they succeed, Congress won't appropriate for so many ships.'

VICE-ADMIRAL SIR WILLIAM KENNEDY, K.C.B.

'I know nothing about submarine boats, and what's more don't believe in them.

'I would sooner be above water than beneath it.'

RIGHT HON. SIR CHARLES DILKE, BART., M.P.

'I am very sorry, but while I thoroughly know the construction of the first French submarines, I have not kept up my knowledge recently, and find the information contained in the second edition of Lieutenant Armstrong's 'Torpedoes and Torpedo Vessels,' published to-day (24th July, 1901), much in advance of my own. There is an excellent chapter on the subject on which I couldn't improve at any point.'

REAR-ADMIRAL S. C. HOLLAND.

'I have no knowledge of submarine boats, and have never even seen one, consequently I am not in a position to write an article or give an opinion as to their merits or otherwise.

'If they can be made sea-going craft they will be very formidable within their radius of action.'

CAPTAIN P. W. D'ALTON, Mem. Inst. C.E., commenting on the loss of the last 'Nordenfelt' boat, of which he was commander, says:—

'On the Horne Reef, off the coast of Jutland, on the 18th of September, 1888, was wrecked the fourth and last of the 'Nordenfelts,' the largest, and in my opinion, the best submarine ever constructed, either before or since that date.'

SIR W. LAIRD CLOWES.

'I have recently set forth my views on the general subject of submarine navigation as it stands at present, and you will find them in the June number of the New Liberal Review. I am afraid that anything more which I could send you would be but a repetition of them as there expressed.'

(The article mentioned is given in toto.)

Mr. A. S. Hurd.

'Until some authoritative information is available from France and America, it must be very difficult to prophesy their future. It does, however, seem possible that with the development of a new light system of electric storage it may be possible to build serviceable torpedo boats, of good speed, capable of diving beneath the surface on the first sign of danger. Such a craft would be most useful by day as well as by night, don't you think? As soon as one of our own boats is available for serious experiment, the Admiralty should be in a position to form very definite conclusions as to the future of the craft.'

Admiral von Tirpitz, of the Imperial German Navy.

'It is true that submarine boats have improved, but they are as useless as ever. Nevertheless, the German Navy is carefully watching their progress, though it has no reason to make experiments itself.'

Contre-Amiral Reveillére, French Navy.

'L'amiral Aube vivait dans les nuages! . . . C'est possible. Mais quel homme a eu une grande influence sur son pays et sur son temps, s'il n'a beaucoup vécu dans les nuages? . . Ce sont ceux que la foule regarde comme des rêveurs qui ont toujours mené et mèneront éternellement le monde.'

Lieutenant M. Loir, French Navy.

'Cet élément des flottes futures est encore à déterminer, mais les résultats déjà obtenus permettent de croire qu'il fera d'ici peu son apparition définitive.'

M. 'D'Armor.'

'Les derniers et retentissants essais du sous-marin le 'Gustave Zédé' semblent indiquer que nous avons un engin qui répond aux conditions militaires indispensables.'

M. CAMILLE-PELLETAN. (TRANSLATED.)

'That a submarine should plunge beneath the surface of the water, and that it should then be able to discharge a torpedo does not prove very much. There is no vessel of this description, however indifferent it may be, which does not accomplish as much. The whole question is to know its navigable, sea-going and manœuvring qualities. If the 'Gustave Zédé,' therefore, in or near a harbour, torpedoed an ironclad, that, I repeat, proves nothing. The unfortunate thing is that it does not appear to have accomplished even that on the occasion referred to, for all efforts to find the torpedo have failed, and it is thus permissible to suppose that it missed its mark. I do not think that M. Waldeck-Rousseau could have seen the submarine effect its submersion and make for the Bouvet. The foremost quality of a submarine, its special guarantee of security, is that of being invisible. The 'Gustave Zédé' will speedily have to be laid up if she betrays her presence so clumsily, but I have not much difficulty in reassuring myself. At the most the 'Gustave Zédé' could only have been seen when, instead of the vessel being nine feet below the surface, her optic tube and probably even her cupola were emerging above the water, an operation which is necessary for the discharge of a torpedo in the desired direction.'

ADMIRAL HICHBORN, Chief Constructor of the U.S. Navy.

'Submarine boats are very efficient for defence, very economical in point of men and money, and are calculated to have a beneficent effect upon a hostile nation.'

A FEW OPINIONS FROM THE WORLD'S PRESS ON SUBMARINE BOATS.

As it is always interesting to know the opinions of the various organs of the press, I have taken a few cuttings at

random from the many thousands in my possession; their study is as amusing as it is instructive.

I.

Daily Graphic, August 23rd, 1901:—

'It is extremely doubtful whether the problem of steering the submarine when under the water, has yet been even approximately solved; yet unless the submarine can hunt down and hit her quarry her range of usefulness is very limited. The Governments of the world will not go to the expense of building and equipping these boats merely for the sake of inflicting upon a certain number of officers and men the very serious discomforts of a voyage under the sea. Our own Admiralty has, happily, proceeded very cautiously in the matter of submarines, and it is to be hoped that it will continue to do so. Whatever the future may bring, our present lies on, not under, the water.'

II.

Army and Navy Gazette, September 21st, 1901:—

'We learn from some of the Parisian papers that the English people are now trembling in their shoes at the advent and progress of the submarine boat. The Admiralty is inundated with anxious inquiries every day, and even from the most distant parts of the Empire the question is asked, 'Have we yet any submarine boats?' Even the reply of Lord Selborne has not sufficed to calm this tremor of anxiety, and the British Government is afraid to speak aloud concerning the terrible problem. We are straining every effort to learn the secret of the 'Narval,' and the Nationalists are afraid we shall succeed, so little confidence have they in the discretion of their own Government. The cry is taken up in Belgium, where we find the 'Patriote' declaring that the clay feet of the British Colossus are now déchaussés. Thus the débâcle is imminent, for the flood of Continental folly is rising round these same feet, and the monster cannot long remain in the vertical position. We confess that we have been unable to detect the symptoms of the serious complaint which has at-

tacked perfide Albion, and that we have felt nothing of this special *frémissement*. On the contrary, we have a somewhat robust belief that these submarine vessels are likely to delude those who depend upon them, and certainly we shall not take them for granted on the faith of the scanty report of the deliberately planned experiments which have reached us.'

III.

Sunday Times, July 7th, 1901 :—

'If we want to retain our supremacy of the sea we must be supreme in the later and more effective, as well as the older and now less effective, though huger, engines of destruction. What is the use of our going on building great and powerful battleships if another country has a boat which can secretly destroy them without its presence being discovered or even suspected?'

IV.

Truth, August 29th, 1901 :—

'To my thinking, the submarine boat has come to stay, and what surprises me is not that it has come now, but that it has not come long before. The problem of submarine navigation does not present any such formidable difficulties as that of navigating the air; and when the torpedo was once invented, the advantages of firing it from a ship, which could be either partially or wholly submerged at will, so as to offer little or no target to the enemy's weapons, might have been 'obvious to the meanest capacity.' There is an interesting article on 'The Tactics of the Submarine' in the current number of the *Monthly Review*, where anybody can see for himself the possibilities which such vessels possess in naval warfare. It should be borne in mind that it is not necessary to send a fleet of submarines on a long voyage under water in order to bring them into action. The boats can always be towed till they are within striking distance, or they may be carried, if necessary, on board battleships or other large vessels. It is even conceivable that unarmoured ships of enormous speed, such as the new turbine craft, might dash across the

sea, and convey submarines to and from the scene of their operations with a speed which no other vessels could match.'

V.

Navy and Army Illustrated, June 29th, 1901 :—

'Here is an instrument which is to revolutionise war, to be a swift invisible prowling terror, and to blow up the poor obsolete ironclad. She is sent under water for twelve hours. During that period her crew are engaged like so many poisoners in the old stories—that is to say, in cooking fumes for their own destruction. Will the crews of submarine boats have to wear glass masks, as the wicked alchemists who made drugs for the Marquise de Brinvilliers are said to have done?'

VI.

Navy and Army Illustrated, August 24th, 1901 :—

'The attitude of the British Admiralty in regard to submarine boats was very studiously concealed, and the announcement that boats were to be built took some by surprise. It was generally admitted, however, that it was quite right we should experiment with a weapon which had been proved to possess a certain element of value. But, at the same time, the decision to build a few experimental boats does not commit us to the adoption of submarine navigation as an element in our offensive and defensive plans.'

VII.

Daily Express, July 24th, 1901 :—

'Indeed, now that France has proven that the future of naval warfare lies as much in what can be done under water as on the surface, the nation that would rule the waves will have to look to submarines as the surest possible means of doing so.'

VIII.

Outlook, September 7th, 1901 :—

'In view of the recent achievements of the French boats in the Mediterranean, it is impossible to regard the outcome of the tests with that indifference which in these days appears to be most congenial to the British public. Let us admit that the submarine has come to stay, and set to work in deadly earnest to study the new problems that are coming into view. This, we believe, is the attitude of mind of Captain Bacon and the experts who will be associated with him, and herein is cause for congratulation. We cannot afford to be left behind in the race.'

IX.

The Graphic, July 13th, 1901 :—

'The submarine is far from perfect yet, as recent French experiments, in which the men working one were nearly asphyxiated, have shown. A disaster may even set it back for a year or two, but the very existence of an elaborate magazine, entirely devoted to its claims, is sufficient to show how deep a hold submarine navigation has taken of the scientific as well as of the popular imagination.'

X.

The Navy League Journal, July, 1901 :—

'The great danger in England is the general indifference with which naval matters are regarded, and the ignorance prevalent concerning them. All nations are now building submarines, and underwater navigation should certainly have its own periodical in English.'

XI.

Newcastle Chronicle, July 11th, 1901 :—

'It may be hoped that the British naval authorities are awake to what is passing. Anything that seems even remotely to threaten our superiority on the ocean demands close attention.'

XII.

Birmingham Weekly Post, August 24th, 1901 :—

'The naval battles of the future, says an expert, may be fought under water. Already the doom of the monster battleship has sounded. The submarine torpedo boat, most formidable and most scientific agent of destruction ever devised, has been appointed to take its place. If naval warfare seems a dangerous thing now, it is about to become a thousand times more so.

'The most powerful ironclad ever constructed is helpless before this deadly weapon of war, which can dart through the water like a fish, which can see without being seen, and which can aim its guns with fatal precision whilst sure of its own immunity from counter attack. Indeed, the entire fleet of Great Britain could be shot to pieces without ever knowing what hit it if a group of torpedo boats should be appointed to this work of destruction.'

XIII.

Manchester Courier, August 31st, 1901 :—

'The utility of submarines is largely a matter of conjecture at present, however, and it is admitted that their range of operations is extremely limited. Also, since the ordinary mariner's compass is quite useless when enclosed in a shell of steel, frequent ascents to the surface are necessary, in order to get the bearings; and, lastly, a Jonah-like life of this kind is irksome in the extreme, and beset with annoyances and dangers. This last objection would, of course, be of comparatively small moment, since British officers and bluejackets would not shirk their duty, however arduous it became. But to launch out into an expenditure of many millions on a new and untried arm of Service in the reckless fashion suggested would be foolish in the extreme.'

XIV.

Manchester Courier, September 9th, 1901 :—

'As an offensive weapon the submarine is yet untried, and it is more than probable that several of them will be

lost or disabled before any satisfactory conclusions are arrived at on this head. Looking at the subject without prejudice, the conclusion can hardly be avoided, that in the naval wars of the future the submarine will play a prominent part.'

XV.

Liverpool Journal of Commerce, August 24th, 1901 :—

'One thing is certain, and that is that the conditions of life on board a submarine when running under water are not such as to inspire seamen with the keenest desire to undertake them. In fact, they are almost unbearable after a comparatively short time; and unless this state can be rectified, the use of the class, even for war purposes, will be circumscribed. The lurking danger to which all on board are exposed of being trapped like rats, owing to some unforeseen mishap to machinery or damage to hull, is one that cannot be overcome, and it is doubtful if men will become accustomed to the life on board a submarine in the necessarily short time that they will be told off for duty on them. Anyway, there appears to be no reason in the world to expect developments in this type of vessel for mercantile purposes.'

XVI.

Bristol Mercury, August 23rd, 1901 :—

'There is no complete submersion, such as would make the craft altogether invisible, for the appliance on which the power of observation depends must be above water—necessarily not much, but still sufficient to arouse suspicion. A well-directed shot would be the inevitable sequel under such circumstances, and France would have a submarine craft and crew the less without the melancholy satisfaction of knowing whether the loss was due to inherent defect, mismanagement, or an unfriendly missile.'

XVII.

Leicester Post, August 23rd, 1901 :—

'It is clear that some radical improvements will have to be made in the new marine monster before it can be safely

trusted to do much mischief to the enemy's fleet, rather than to its own crew and aquatic allies.'

XVIII.

Notts Express, August 22nd, 1901 :—

'It is satisfactory to see that the Admiralty is alive to the importance of this new development in naval warfare, for the maintenance of our naval supremacy is of such vital importance that no invention which threatens it in the faintest degree can be disregarded. Otherwise we may have a rude awakening some day at the hands of more enterprising rivals.'

XIX.

Hampshire Advertiser, July 6th, 1901 :—

'An outrigged torpedo will not meet the attacks of a submarine boat when those attacks are possible, and no one knows it better than the staff of the 'Vernon.'

XX.

Brighton Evening Argus, October 4th, 1901 :—

'The shortcomings of the submarine are obvious enough. They are so slow in movement, that only by a most improbable chance could they be effective against ships under weigh. Under water they are practically blind; and if they should rise to take their bearings in the neighbourhood of a hostile fleet, and be perceived, they would be the easiest possible prey to any destroyer which might be within a mile of them, seeing how many minutes it takes for them to become re-submerged. Again, any attempt to work them from a harbour against a blockading fleet, or to slip into a harbour from outside, might be rendered almost certainly fatal by simple defences. For instance, a submarine running with dome or optic tube above water would be rendered helpless, and, in all probability, sunk with all hands, by collision with a floating beam. Conditions might be imagined in which the submarine would be very useful, and it is well that our navy should be provided with and endeavour to perfect this class

of vessel; but their possession would be a more than doubtful boon if it divided attention from the construction of battleships and cruisers, and caused a lowering of the standard of strength now considered essential.'

XXI.

Edinburgh Evening Despatch, August 28th, 1901:—

'Should have taken timely action. Our naval officers cannot too soon make themselves familiar both with the powers and the limitations of this new naval weapon.'

XXII.

Aberdeen Engineering Gazette, July 11th, 1901:—

'We need not, however, fear that the science of naval warfare will be violently disturbed by the introduction of this new kind of craft. We may remember the scare that was caused by torpedoes, and the little actual damage that has been caused by them. Their powers for mischief have been neutralised by specific precautions, and their influence is largely of a moral kind. These new vessels are just torpedoes manned by a crew, and much greater experience of their capabilities and reliability will be necessary before we can consider the problem settled. Prophecies as to the immediate decay of Britain's supremacy are therefore a little premature, though anything which threatens that superiority demands the close and serious attention of our naval authorities.'

XXIII.

Dundee Evening Post, July 4th, 1901:—

'The staff of the torpedo ship 'Vernon' at Portsmouth have for some time been carrying out experiments, with a view to ascertaining a means of destroying submarine boats. The engineer gives some general particulars of the result of these trials, which it claims to be 'one of the most important inventions of the age.'

'In the present state of the science a submarine attacking

a ship is bound to come to the surface to take bearings, or else to betray her presence with an optic tube or periscope. With the new invention—evolved in the 'Vernon,' and tried before the Lords of the Admiralty last week, the sighting of a submarine entails her almost certain destruction. Sighting is now practically certain.'

XXIV.

Northern Whig, Belfast, September 9th, 1901 :—

'There has been a good deal of discussion of the 'submarines,' but if reliance is to be placed on current report these remarkable vessels have been surpassed. A sensation has been produced by the claims made on behalf of a new class of vessels named the 'Actinaut,' patented by Messrs. Orling and Armstrong. It is a kind of torpedo; it can be worked and controlled entirely by a person on shore, or even on board a ship of war, or from a balloon. It has no crew, and is controlled by a series of rays such as are familiar to us now in the case of wireless telegraphy. Such an apparatus is beyond anything yet dreamed of in connection with submarine navigation.'

XXV.

Weekly Irish Times, July 13th, 1901 :—

'Though Great Britain has exercised her usual caution in regard to submarine boats, she has ordered five of the 'Holland' type, one of which will be ready for trial in September.'

XXVI.

Auckland Star, July 13th, 1901 :—

'Much has been written about this terrible and wonderful engine of war, which can deal out death and destruction while sailing, safe and unseen, below the surface of the water. The chief obstacle in the way of perfecting boats, is the difficulty of seeing under water.'

XXVII.

Sydney Morning Herald, July 6th, 1901 :—

'In the House of Commons Mr. Arnold-Forster has been stating the intention of the Admiralty to strengthen the Mediterranean squadron with additional cruisers and torpedo-boat destroyers, and it was announced some time since that England, like the United States, had been giving considerable attention to the question of submarine navigation as applied to warlike uses. Can it be that the naval battles of the future are destined to be fought, not as between Tennyson's navies in the air, but below the ocean's surface?'

XXVIII.

South Australian Register, Adelaide, April 12th, 1901 :—

'The recently announced British naval programme provides for the building of four submarines of the 'Holland' type; but, as we have already remarked in commenting on the proposals, there seems reason to doubt the wisdom of this part of the programme. Might it not be better to begin by building one submarine, and at the same time fitting another vessel with sound receivers and everything else known to modern science by which attacks from under water could be repelled? From the results of many trials of manœuvres, including feigned assaults by submarine boats, some true idea of the utility of the new craft could be secured.'

XXIX.

Cape Mercury, King William's Town, August 16th, 1901 :—

'There is a bitter disappointment in the minds of French newspaper writers that the British Admiralty have so promptly taken up the problem of the submarine boat. We have stolen the brains of their naval inventors they say, and they are very wrath.'

XXX.

Bombay Gazette, April 27th, 1901 :—

'If Jules Verne's dream of submarine navigation has not yet been quite fulfilled in every respect, the submarine boat has been sufficiently developed to be of practical value in naval warfare.'

XXXI.

Times of India, April 13th, 1901 :—

'Whether the submarines will ever form an important part of the modern navy is a matter which the future must decide. But that they can do damage was shown as long ago as the American War of Secession, when a little submarine sank the 'Housatonic,' a Federal ship of 1,200 tons, which was blockading Charlestown Harbour.'

XXXII.

Civil and Military Gazette, Lahore, July 6th, 1901 :—

'The success of the submarine boats at the French naval manœuvres is not surprising. After all that has been said about these new engines of warfare, they would be condemned indeed, if they could not play the part assigned to them at manœuvres. Whether their success in this respect proves that they would be equally formidable in actual warfare is another matter. We have heard a good deal lately about defects in the supply of air for the crew, and the failure of the view-finding apparatus, called the periscope, below a depth of twenty feet. If these difficulties have now been successfully surmounted, well and good; but if not, the value of the operations as an indication of the capacity of submarines, will depend upon the nature of the manœuvres, the state of the weather, and the sea, and other circumstances. If the torpedo battleships were in fairly close formation in smooth water, and if the weather was clear, the success of the submarines does not exceed expectations. It would show what

has all along been admitted, that submarines may be very effective against a blockading fleet. But for the purposes of aggression on the high seas their efficiency has yet to be proved.'

XXXIII.

Rangoon Gazette, April 18th, 1901 :—

'The submarine boat never recommended itself to the British Admiralty, but this type of vessel could no longer be ignored after the reported success which had attended the experiments of the United States and France with submarine boats. This new weapon for offensive warfare by sea is by no means perfect, but the French and American experiments have proved that it is possible to completely submerge a vessel, keep it under water a considerable time, progress under water and steer in any particular direction and discharge a torpedo from the submarine boat at any object it is desired to destroy. The first naval power in the world cannot afford to ignore such a formidable weapon for offensive purposes, and one which may even revolutionise naval warfare.'

XXXIV.

Rangoon Gazette, May 7th, 1901 :—

'As far as submarine boats are concerned there will always be a great element of uncertainty, more especially in times of intense excitement; any hitch in the difficult steering, any breakdown of the complicated mechanism, at a critical moment would be certainly fatal. There can be no doubt of the utility of a boat which could run a blockade without being seen, and in comparative safety.'

XXXV.

Petit Journal, Paris, September 25th, 1901 :—

'The Sirène is at present the most perfect of the submarines. She possesses the following qualities :—Rapidity of submersion, the time occupied being five minutes; perfect

stability and habitability; wide radius of action; and a powerful armament. In a word, she is the true type of an independent submarine, capable of acting on the offensive.'

XXXVI.

Le Yacht, September 21st, 1901 :—

'Pour en revenir aux sous-marins, la question de leur valeur propre est depuis longtemps résolue chez nous; il reste, certes à faire quelques expériences sur leur meilleure utilisation, sur leur emploi rationnel. On y travaille et des essais comparatifs auront lieu prochainement avec les différents types. Après le succès du Zédé, aux dernières manœuvres navales, et celui du Morse, lors de la récente inspection des défenses mobiles du 1er arrondissement par l'amiral Fournier voici que nos sous marins vont encore attirer sur eux l'attention de toutes les nations maritimes depuis qu'ils sont allés saluer à Dunkerque l'emperuer de Russie. Le 'Narval,' le 'Morse,' et l' 'Algérien' ont en effet, a Dunkerque, pris place à côté de nos autres unités navales; ils ne manquent plus maintenant à aucun exercise, à aucune solennité, ils ont donc bien acquis droit de cité dans notre marine, et c'est la meilleure preuve de leur valuer militaire. Cela fait, sans contredit, grand honneur à la marine française.'

XXXVII.

Le Yacht, October 5th, 1901 :—

'La navigation sous-marin est entrée aujourd'hui dans le domaine des applications pratiques, L'Amirauté anglaise elle même, qui n'a rien à gagner et tout à perdre à voir se généraliser le genre de guerre qu'elle comporte, a fermé les yeux tant qu'elle a pu, affectant de mépriser les nouveaux engins; mais les résultats obtenus en Amérique et surtout en France l'ont forcée à entrer bon gré dans la voie du progrès. C'est ainsi qu'elle a été la dernière à developper sa flottile de torpilleurs. Enregistrons donc la commande qu'elle vient de faire de cinq sous-marins type 'Holland,' comme un aveu de la puissance de l'unité de combat nouvelle, d'autant plus redoutable qu'elle est invisible.'

XXXVIII.

The Inter-Ocean, Chicago, Ill., July 7th, 1901 :—

'The decision of the British Admiralty, announced in Parliament early in the session, to build a few submarine vessels by way of experiment, was not due to conviction as to the merits or usefulness of the type, but was a concession to newspaper clamor. The work is proceeding in perfunctory fashion, and it is open to doubt whether a single boat will be finished during the current financial year. It has transpired in naval quarters that some of the most respected members of the naval board protested with remarkable vehemence against wasting money on the new-fangled craft, their main argument being that submarine boats at the most could only be useful for coast or harbour defence, for which purpose torpedoes were much more efficacious.'

XXXIX.

New York Sun, August 4th, 1901 :—

'It doesn't take a very vivid imagination to picture the possible military usefulness of a torpedo boat that may travel on the surface, on bottom, and in between the two, and which, besides its power of attack, may be able either to plant or to remove submarine mines at will or sink to the bottom and put itself at once into telegraphic or telephonic touch with a shore station miles away.'

XL.

New York Sun, August 4th, 1901 :—

We cannot repeat too often that the submarine reserved for the defence of harbours and coasts is a fighting unit of great value. Later it is possible, and even probable, that it will become a sea-going boat, and that day it will not be required to be carried on a man-of-war. In the meantime, however, let us leave it to its duties, that of guardian of our maritime frontier.'

SUBMARINE NAVIGATION

XLI.

New York Journal, August 30th, 1901 : —

'The Paris *Matin* asserts that the recent exploit of the submarine torpedo boats 'Gustave Zédé' and 'Morse,' prove that vessels of this type are safe and pleasant to live in, discharge torpedoes perfectly, and can be easily handled. It concludes : —

'"Eighteen months hence France will be able to defy the fleet of any other country. Whatever efforts others may make, it will be impossible to overtake us in this respect."

'There is good reason for the *Matin's* cheerfulness, France has now built, or under construction, no less than forty-two submarine boats. The United States has eight, and England five. No other Power has any.

'That we make even as good a relative showing as we do is due entirely to the insistent pressure of public opinion. The official class here has opposed a dogged resistance to every attempt to put this country in the lead in submarine navigation. Congress has forced eight submarine boats upon the navy, against the bureaucracy, just as it forced some increase in the speed of our battleships.

'The attitude of the official mind in France has been very different. There the submarine boat has been welcomed. President Loubet himself visited the 'Gustave Zédé' and the 'Gymnôte' at Toulon, accompanied by the Ministers of Marine, Foreign Affairs, and Public Works, a couple of admirals, and a number of other officials.

'On this occasion the President and his party spent half an hour under water.

'In April of this year the French Government ordered twenty new submarine boats, while, thanks to the opposition of the Navy Department clique, our own progress in that direction is at a standstill.

'In contrast with the enthusiastic welcome extended by the French authorities to every step in advance in under-water navigation, our own authorities have discredited and obstructed every movement in that direction. If they could have had their way nothing whatever would have been done.

'They would not let Mr. Holland attempt to clear the mines

out of the entrance of Santiago harbour at his own risk, although if he had done so, the lives of a thousand American soldiers might have been saved, and Cervera's fleet might have been added to our navy instead of going to pieces on the rocks.

'Three rear-admirals, chiefs of bureaus of the Navy Department, appeared before the Naval Committee of the House last winter to protest against the construction of any more submarine boats.

'Admiral Bradford made the crushing revelation that submarine boats had been known in this country since the time of Fulton. That was enough to prove them worthless, of course. Fulton also invented a steamboat, so presumably Admiral Bradford would have us dismiss every craft that goes by steam.

'Admiral O'Neil informed the committee that submarine boats could be of no value, 'particularly in view of modern naval tendencies, which insure short, decisive wars, settled on the high seas by great armoured fleets, harbours being already effectively defended by forts and mines.'

'Thus might a reckless innovator proposing to introduce Krupp armour plate and turbine engines have been crushed in the times of Trafalgar, by the reminder that modern naval tendencies insured wars settled on the high seas by great fleets of wooden sailing three-deckers.

'It does not seem to have occurred to Admiral O'Neil that the condition of warfare when submarine boats were present might possibly differ from the conditions prevailing in their absence.

'The treatment accorded by the Navy Department barnacles to the submarine boat is the same that they have given to every proposed improvement in naval appliances. When the rest of the world was building breech-loading rifles they were still casting muzzle-loading smooth-bores and talking owlishly about the comparative merits of the 'racking effect' of round shot, and the punching effect of conical projectiles.

'When other Powers were protecting their ships with solid plates of armour they were making 'laminated' turrets, constructed like jelly cake of layers of boiler iron.

'They kept regularly one cylinder behind other countries in

the construction of machinery, using simple engines when foreigners were using compound, compound when triple expansion had been adopted abroad, and triple expansion when quadruple expansion had proved successful in Europe. No doubt they will be the last on earth to adopt the turbine.

'The American bureaucrats are not only jealous, but incompetent. They do not want to get out of ruts themselves, and they dislike any man who does. That is sufficient explanation of their treatment of Schley.'

XLII.

Boston Journal, Mass., June 2nd, 1901 :—

'The truth seems to be that the submarine boat does not and cannot 'revolutionize' naval warfare. It is an auxiliary at the best—an auxiliary for coast and harbour defence. So imperative are the limitations of their peculiar design that the submarine boats cannot go far to sea, and can never accompany cruising squadrons.'

XLIII.

The Republican, Denver, Colorado, July 9th, 1901 :—

'While it is not likely that the British Navy will prove as vulnerable as the British Army has recently shown itself, it is also true that no great maritime nation can afford to overlook the opportunities that may be offered by designers of submarine boats.'

XLIV.

The Tribune, Salt Lake City, July 9th, 1901 :—

'The submarine boat was thought to be a mighty terror to modern navies, but now the British Admiralty announces that it can destroy them at will.'

SUBMARINE NAVIGATION

XLV.

Montreal Gazette, July 25th, 1901 :—

'Lieutenant Carlyon Bellairs, R.N., thinks France has done Great Britain a service in inventing the submarine torpedo boat. The submarine, he points out, can only operate with hope of success against a stationary enemy, as a ship at anchor. It is slow and half blind, and need cause no terror to the moving ship out in the sea. This is where Mr. Bellairs, judging from past experience, thinks the British vessels will be found as a rule, and, from the same experience, they will have to seek their enemy in harbours or protected anchorages; and it is here that the British submarine boat will have its chance. The British people who have watched their navy in war and in peace will have confidence enough in its men to take stock in Mr. Bellairs' theory.'

THE SUBMARINE IN POETRY.

Erasmus Darwin, an 18th Century poet, wrote in 1791 :—

'Lo, Britain's sons shall guide
Huge sea balloons beneath the tossing tide;
The diving castles, roofed with spheric glass,
Ribbed with strong oak, and barred with bolts of brass,
Buoyed with pure air shall endless tracks pursue,
And Priestley's hand the vital flood renew.
Then shall Britannia rule the wealthy realms
Which ocean's wide insatiate wave o'erwhelms;
Confine in netted bowers his scaly flocks,
Part his blue plaines, and people all his rocks,
Deep, in warm waves, beneath the line they roll,
Beneath the shadowy ice-isles of the pole,
Onward, through bright meandering vales, afar,
Obedient sharks shall trail her sceptred car,
With harnessed necks the pearly flood disturb,
Stretch the silk reign, and champ the silver curb;
Pleased, round her triumph wondering Tritons play,
And sea-maids hail her on the watery way.'

—*Economy of Vegetation*, Canto IV.

SUBMARINE NAVIGATION

Ben Jonson in 'The Staple of News,' Scene I., Act III., wrote:—

THOMAS — They write here one Cornelius' son
Hath made the Hollanders an invisible eel
To swim the Haven at Dunkirk and sink all
The shipping there.

PENNYBOY—But how is't done?

CYMBAL — I'll show you, sir.
It's an automa, runs under water
With a snug nose, and has a nimble tail
Made like an auger, with which tail she wriggles
Betwixt the costs of a ship and sinks it straight.

PENNYBOY—A most brave device
To murder their flat bottoms!

This early poetical reference to Van Drebbel's invention is of especial interest, for it shows that even when the submarine was in its veriest infancy it created enough public interest to make its mention possible in a play, whereas to-day, when the advance of science has placed a potent naval weapon in the hands of man, its existence is ignored, and even where noticed the submarine boat is held out as an object of ridicule.

THE END

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Rivista Marittima.

Besides the publications mentioned above, which are indeed only a portion of the books and pamphlets referred to, I have extracted much of my early information, and details of the history of torpedoes and explosives, from various works and encyclopœdias in the Bodleian Library. Here also I found the only Spanish book on Submarine Navigation—a complete account of 'El Ictineo,' by the inventor, Narciso Monturiol. Should any of my readers wish to obtain either of the volumes above mentioned, I shall be most pleased to give them the names of the publishers and the place of publication, these being left out owing to the amount of additional space they would take up. I should also esteem it a favour if any of my readers, coming across a book dealing with Submarine Navigation, not included in the above list, or hearing of any new invention or experiments, would communicate either directly with me or through my publisher.

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